ROADS And STREETS
Vol. 79, No. 11 November, 1936
A GILLETTE PUBLICATION
ESTABLISHED 1906

Modern traffic requires standards of perfection in construction which can only be attained through the proper combination of specialized equipment, trained personnel and able management.

Some Relations of the HIGHWAY CONSTRUCTION OUTFIT *To Unit Operating Costs*

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IN MODERN highway construction work the maximum rate of production which may be attained from any given construction outfit is largely fixed by the mechanical equipment or plant which is put on the job and by the managerial ability devoted to its operation. In other words, the plant assembly on any particular job determines very definitely the maximum rate of production possible of attainment on that job, while the ability of the management determines how nearly and how regularly this maximum rate will be maintained in actual operation. Furthermore, the daily or hourly operating cost of any given modern construction outfit is very nearly independent of its rate of production; consequently the unit operating cost of any such particular outfit varies inversely with its rate of production. Unit highway operating costs for any particular outfit therefore depend, first, on the actual adaptability of the equipment to the line of work to be performed and, second, on the initiative and ability exercised by the management.

The proper selection of the equipment or plant is one of the essential functions of construction management. To the contractor, therefore, whether in the preparation of a bid price for new work or in outlining a plan of attack on a contract already awarded, the most important question is, "Will the particular pieces of equipment

In highway work the only combination which can attain high production efficiency and low unit operating costs is a properly balanced set-up of men, equipment and management.

selected so fit into the proposed or established plan of operation as to form a dependable and smoothly functioning link in the entire process of production at the rate required from the plant as a whole?" Furthermore, in determining the value or desirability of any given piece of equipment, the most important consideration is not its own individual operating cost but its effect on the final unit cost of the finished product.

High Level Production Makes Low Unit Costs

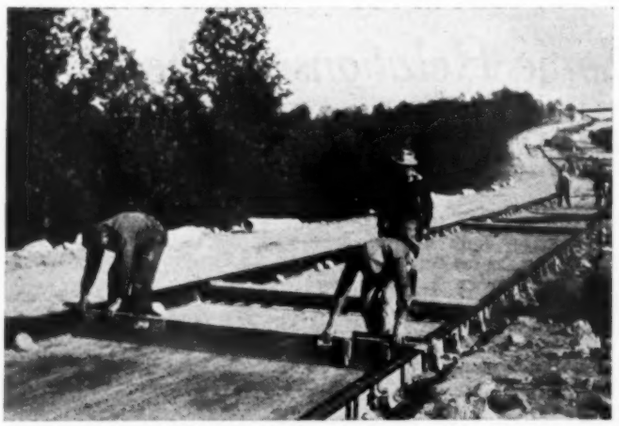
In order to obtain low unit operating costs with any construction outfit production must be maintained at a high level. The highway equipment assembly must be definitely adapted to the work to be performed. It must be strong and rugged, easy to operate, and of sufficient capacity, and each individual piece or part must be capable of performing its particular function efficiently and effectively. The various separate or individual units of assembly must also fit together in every way as to capacity, reliability and rate of operation so as to form a well-coordinated, smooth-working plant particularly well adapted for the effective and efficient performance of the work to be done.

Furthermore, most highway construction work now involves the repetitive performance of one or more of a series of progressive operations in order to obtain the finished product. Consequently in order to attain fully efficient operation the capacity and performance ability of each of the separate units of the plant must not be less than the maximum desired rate of the entire plant, and collectively the separate units must be able to work in such unison or tempo as to cause no interference or delay to any of the other units. Since any delay or interference on the part of any one of these interdependent units or groups causes a corresponding reduction in the rate of production of the key equipment, dependable, synchronized operating ability is one of the most outstanding requirements. One poor, unreliable or unsynchronized piece or group in the direct line of production will inevitably reduce the production of the entire plant at least to its own slower rate. Final production can, therefore, be no higher than the rate of the lowest or slowest unit or group of units in the direct line of production.

It is also true that such variations as are found to exist in the direct operating cost of any piece of highway equipment requiring close synchronization with the key producer are usually insignificant in comparison with the cost of the losses that piece of equipment can inflict on production when it is lacking in capacity, dependability or operating regularity. This holds true in all lines of highway construction work where modern equipment and modern methods are used. To be of any definite value to the contractor the unit operating costs of individual units of the plant assembly must therefore show not only their own operating cost but also the effect of their own behavior on the unit operating cost of the finished product of the entire assembly. Without the latter information, unit operating costs of individual pieces of equipment may be entirely misleading.

How Equipment Assembly Is a Major Factor

In order to illustrate more fully how and to what extent the equipment assembly or plant used on any particular job is a major factor in determining the unit operating cost a comparative selection from 35 actual outfits will be used as a typical example of an average concrete paving outfit. This outfit, as shown in Table I, consists of a 27E paver as the key equipment and with



The subgrading and setting of the forms should be manned and equipped to maintain the average rate of the mixer with sufficient headway to absorb all spurts faster than the average rate.

which the other units are coordinated. At the materials yard which is located on a railroad siding these units include a 1¼-cu. yd. crane, a 3-compartment aggregate bin with weighing batcher, and a bulk cement bin with elevator and weighing batcher. On the subgrade we find a 10-ft. blade grader, two medium heavy crawler tractors, a 3-wheel roller with a scarifier attachment, a 1-yd. rotary scraper, a mechanical subgrader, a form grader and a light truck, and in addition to the usual templates, about 4,000 road-feet of 9-in. forms and the customary hand tools. On the finishing we find a finishing machine equipped with a vibrating attachment and center joint cutter, a concrete strike-off and the usual bridges, floats

and small tools. For the water supply and curing, which was with burlap and then an earth cover, the equipment consists of a heavy duty triplex pump, 3 miles of 2½- and 3-in. pipe, hose and hand tools. The hauling is done by a subcontractor with his own 2-batch trucks of which 11 are available although 15 were in use on the longest hauls, the additional trucks with drivers being hired locally as required. The average number used was 10. A 2½-ton truck for hauling steel and joint materials and general utility use and a car for the superintendent completes the mechanical equipment on this particular job.

TABLE I.—EQUIPMENT AND PERSONNEL OF A FAIRLY TYPICAL CONCRETE PAVING ORGANIZATION PERFORMANCE CHART

Equipment	Personnel
Subgrade:	1 foreman
1 blade grader, 10 ft.	1 blade operator
1 roller, 10-ton with scarifier	1 roller operator
1 rotary scraper, 1 cu. yd.	2 tractor operators
2 tractors, one 60, one 30 hp.	1 subgrader operator
1 subgrader	8 laborers
	14 total on subgrade
Forms:	1 foreman
1 formgrader	3 formsetters
1 truck, 1½ ton	1 truck driver
Forms, 4,000 ft.	5 laborers
	10 total setting forms
Materials yard:	1 foreman
1 crane, 1¼ cu. yd.	1 crane operator
1 aggregate bin and weighing batcher, 3-compartment bin	2 batcher operators
	2 cement car men
1 cement bin with elevator and batcher	2 laborers
	8 total at materials yard
Batch hauling:	
11 2-batch trucks	10 truck drivers
Paving and finishing:	1 foreman
1 paver, 27E	1 paver operator
1 finishing machine with vibrator	1 finishing machine operator
	1 truck driver
1 mechanical strike-off	3 puddlers and spaders
1 truck, 2½-ton	4 finishers
1 concrete grinder	3 joints and reinforcing steel
	2 laborers
	16 total at paver
Curing and water supply:	1 foreman
1 pump, triplex, 80 gal. per min.	1 pump man
	2 pipeline men
2 burlap carts	2 burlap men
3 miles, 2½-in. pipe	6 laborers
	12 total on curing and water supply
Miscellaneous:	1 superintendent
1 car	1 timekeeper
1 machine shop	2 mechanic and helper
	2 watchmen
	2 water boys
	8 total miscellaneous
	78 Grand Total

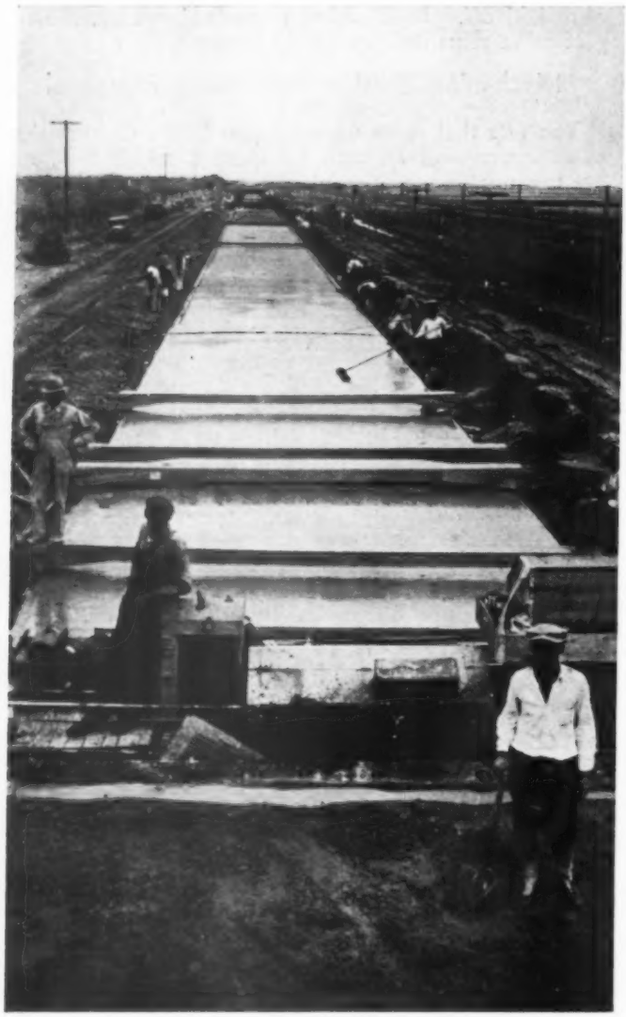
This equipment pretty definitely determined the number of men necessary to obtain an efficient producing organization. For most of the work the total organization, including the hauling, consisted of an average of 78 men, as shown in Table I. On the longest hauls all the subcontractor's trucks were employed plus three or four additional hired trucks and drivers, while on the shortest hauls all the hired and some of his own trucks were laid off. In all other respects, however, the organization remained practically constant.

Mechanical Set-Up Determines Personnel

The fact that there were 68 men in the organization, or an average of 78 with the usual truck drivers, was not just a whim or an accidental coincidence. The number of the men and their positions were rather definitely fixed and demanded by the mechanical set-up under the particular conditions encountered on this job. Thirteen belong to or form a part of the management; 22 are operators of specific pieces of equipment; 20 are assigned to distinctive, essential jobs mostly associated with the proper functioning of the equipment; and only 23 are termed laborers, and even these are necessary to perform the incidental hand work for which no direct equipment is provided but which must proceed at the rate set by the major equipment. The specifications required a 1-minute mixing time. The mixer was in excellent condition and the operator was alert and well-trained so that with very dry sand and aggregate an operating cycle of 72 seconds, or 50 batches per hour, was possible. On the present job, however, the sand was moist to wet so that on actual timing the mixer cycle on this job was found to be 75 seconds, or a possible 48 batches per hour. This then was the rate at which all the directly dependent operations had to be manned, that is, the batching, hauling, placing and finishing.

While no paving organization ever succeeds in working continuously at its maximum possible rate, the dif-

In most highway work production is dependent on each piece of equipment constantly doing its share and doing this share in proper coordination with the key producer.



In concrete construction the batching, hauling, placing, finishing and curing must be equipped and manned to maintain the maximum actual operating rate of the mixer.

ference between the cost of the personnel necessary for maintaining this maximum rate whenever it can be attained by the mixer and that necessary for maintaining only the average general rate of the mixer is so small that it never pays to hold back the production rate of the key equipment. On the best managed jobs and when conditions are favorable this difference between the possible rate and the actual rate approaches zero; first, because the average production rate is held close to the maximum possible rate and, second, because the equipment selected for these directly dependent operations has sufficient reserve capacity to absorb any probable spurt in the rate of the key producer. In this way the additional work from any ordinary increase in the working rate of the key equipment is mostly absorbed by the supporting equipment and only very little of the extra work is thrown on the hand workers. This is equally true for all types of highway construction work. On the typical paving job used as an illustration the maximum rate attained for a full day's operation was 45 batches per working hour, the maximum 1-hour rate was 48 batches, and the average rate for the job was 40 batches per working hour.

For such operations as setting forms, curing, and the preparation of the subgrade, except for the fine work at the mixer, a sufficient headway is always possible so that the average daily rate of the key equipment is the rate for which these should be manned. Of course, if the contractor succeeds at any time in improving his average daily production rate, then a corresponding increase must be made in the average daily progress with which the above operations should proceed. They must always be carried on with a sufficient reserve or headway to be able to absorb all spurts in mixer operation without imposing any delay to production. Insofar as manning, organizing and equipping any highway construction job is concerned, the essential slogan should therefore be: "Never permit production by the key equipment to be delayed. Such delays never fail to increase unit production costs."

Other Factors Affecting Unit Costs

But many other factors aside from the rate of production also affect unit construction costs. Thus, the labor cost per working hour (that is, each hour the crew is out on the job) depends, first, on the number of men required to operate the equipment for the desired rate of production under the particular job conditions and, second, on the wage rates paid on the job. The average number employed in 35 concrete paving jobs, some of which however had an excessive number of batch trucks since local trucks were hired on a batch-mile basis, was 87; the minimum was 58 while the maximum was 129. On half of these jobs the total employment was between 70 and 86. The wage rates paid on highway construction work also vary a great deal not only from year to year but from place to place. Sometimes we also find seasonal variations in the wage rates. In general, however, with proper modern equipment labor forms less than half of the total hourly operating cost.

In the example shown in Table I the hourly management and labor cost formed 45 per cent of the total operating cost, while the equipment contributed 55 per cent. In a further subdivision we find that about 34 per cent of the total cost was for depreciation, taxes and registration fess and about 12 per cent was for repairs, tires, and similar charges, while the remaining 9 per cent was for supplies such as gas, oil and grease.

The above percentage distribution will, of course, vary with the wage rates, the price of supplies on each particular job, and the kind of attention and supervision which the management exercises over the operation and care of the equipment; for depreciation rates as well as repair costs are also amenable to managerial control within rather wide limits, the same as is true of production rates. Unit production costs, whether as to the part due to labor or the part due to equipment depreciation or repairs, or to any other cause except taxes, registration fees and similar imposts, are therefore fixed neither as to their total annual amount nor as to their unit contribution to the unit cost of production.

Fuel and Lubricant Costs

With the present modern highway construction equipment the purchase of fuel and lubricants forms a constant source of expense which sometimes assumes an unwarranted importance in the mind of the contractor. As a matter of fact, under normal conditions the cost of fuel, oil and grease may in general be expected to form only about 10 or 15 per cent of the total operating costs. On the typical average concrete paving job previously used as an illustration the total cost of the fuel and lubricants formed only 9 per cent of the total operating cost. The actual cost will of course vary with the price of these supplies as well as with the condition and type of the equipment and the care and skill of the operators.

but the total of such supplies will always form a relatively small item as compared to the cost of labor, equipment operation and ownership expenses. Table II shows the approximate average amount of gasoline required per working hour for the ordinary operation of the indicated pieces of highway construction equipment as obtained from these studies. Under most normal operating conditions oil consumption for the entire plant may be expected to be about 1/30th to 1/45th of the gasoline consumption. About one-tenth of a pound of grease may also be expected to be used for each gallon of gasoline.

TABLE II.—RANGE OF GASOLINE CONSUMPTION BY HIGHWAY CONSTRUCTION EQUIPMENT PER WORKING HOUR UNDER AVERAGE OPERATING CONDITIONS

Equipment	Gallons per working hour
Power shovels:	
¾ cu. yd.	3.0—4.5
1 cu. yd.	4.0—5.5
1¼ cu. yd.	5.0—6.5
Trucks:	
5 ton	1.5—3.0
3½ ton	1.0—2.5
1½ ton	0.7—2.0
Tractors, crawler:	
30 hp.	1.5—3.0
60 hp.	3.0—5.0
Road rollers, 3-wheel	
5 ton	0.5—1.5
10 ton	1.0—2.0
Patrol graders:	
30 hp.	1.5—3.0
Air compressors:	
110 c.f.m.	1.5—2.5
310 c.f.m.	3.0—4.5
Concrete paver:	
27E	3.5—5.0
Dual drum	4.5—6.5
Finishing machine:	
10 ft. width	0.5—1.5
20 ft. width	1.0—2.0
Pump, triplex:	
Heavy duty, 80 gals. per min.	1.0—2.5
Crane:	
1 cu. yd.	3.5—5.0
1¼ cu. yd.	4.5—6.0
Elevating grader:	
Engine-driven belt	2.0—3.0

Unit Labor Costs Vary

While the size of the personnel required on any particular job is largely fixed by the equipment and the specification requirements, this does not mean that the unit labor costs on all similar jobs are even remotely equal. Not only does the total daily or hourly cost of this personnel vary with the wage rates on the particular job, but the unit labor cost on the job varies both with the wage rates and more especially with the efficiency with which the entire outfit is operated. Thus, if the average wage rates had been such that the pay roll for the average personnel on the job in question as given in Table I would have been $35 an hour in one case and $45 in the other, then the unit labor costs would have been the same when the production was 35 batches per hour in the first case and 45 batches in the second. But if the wage rates had been reversed so that the crew receiving the lowest wage rates would have been the one having the highest production, then instead of each having a unit labor cost of $1 per batch the unit labor cost would have been 77.8 cents per batch for the first and $1.286 per batch for the second. Thus unit labor costs mean little or nothing unless we also know both the wage rates and the production rates.

Breakdowns impose double penalties on the contractor: first, the cost of the repairs; and second, and usually the most expensive, the cost of the idle time or lost production.

For such items as preparation of the subgrade, curing, setting forms and hauling, the number of men required varies considerably with particular job requirement. On the 35 jobs studied the average number of men used on the subgrade was 14 but the number actually used varied from a minimum of 7 on one job to a maximum of 25 on one job. Fourteen men were used on 6 jobs and thirteen men on 8 jobs. The curing is another place at which the particular job conditions and specification requirements also greatly affect the number of men actually required. In the hauling the length of haul, size and condition of the hauling units and the condition of the hauling road are all factors which enter into determining the number of trucks and drivers required.

Two short sections of hose would effectively check this kind of time loss.

The ability of any given piece of equipment to produce useful work, its longevity and its economical operation depends on how that equipment is used, cared for and maintained.

Fixing Total Ownership Equipment Charges

The kind and amount of equipment with which a job is tooled or supplied naturally fixes the total equipment ownership charges for that job. These charges, however, are far from uniform. In the field we find that the rate of depreciation of most equipment, and especially of heavy equipment, varies greatly, first, with the amount of use; second, with the care and skill with which it is operated; third, with the original quality of the equipment; and fourth, with the care and attention bestowed on it by the management. That the life of any piece of mechanical equipment varies greatly with the way in which it is used and cared for is well known. Practically every contractor has had abundant experience of how one operator will wear out a given piece of equipment much faster than another. It is not uncommon to find that of two men operating identical pieces of equipment throughout their useful life under exactly similar conditions, one man will secure about twice the total production of the other. Neither total production nor total age is thus a very reliable basis for obtaining such comparable data as might prove useful in measuring or forecasting the depreciation of any given piece of equipment. Too much depends on both the amount of use made of the said equipment during each year and on how skillful and conscientious is the operator who uses the equipment.

Management Important Factor in Determining Equipment Depreciation

And while original quality may generally be fairly represented in the first cost of the equipment, management enters as a very important and frequently as the deciding factor in determining the actual rate at which the equipment really depreciates. The ability and alertness of the management is frequently the determining factor in fixing the proportion of the available working season which is utilized in actual productive activity; or in other words, the length of time the equipment is actually employed during the year. The management is further responsible for the employment of the operators and therefore indirectly responsible for the skill and care with which the equipment is operated. On the management also rests the responsibility for the care and attention given the equipment in regard to providing systematic repairs, inspection, servicing, storage and protection. Wise and able management in regard to these points mean not only lower repair costs and reduced delays and interruptions to production but a longer working life for the equipment, and hence lower depreciation rates. Actual equipment or plant depreciation is therefore at a different rate for almost every contractor and this individual rate will probably vary from year to year.

The field of highway equipment maintenance offers many illustrations of the extent to which the contractor may control the rate of equipment depreciation. Thus it is well known that timely and adequate maintenance of all highway construction equipment is a prerequisite to its effective and economical production of useful work, to its longevity, and to its economical operation. For the attainment of such timely and adequate equipment maintenance the basic requirements are few and simple, in fact but three in number, as follows: (1) correct and sufficient lubrication of all bearings and moving parts; (2) the maintenance of correct adjustment of all parts of the entire equipment; and (3) immediate attention to all evidence of any need for minor repairs. As a corollary to these rules we also have the requirement for proper storage when not in use.

Most highway construction equipment works under very severe conditions. Dust, dirt and exposure plus hard usage take their immediate toll whenever the lubrication of any part is less than perfect. Adequate lubrication therefore means not only sufficient lubricant at all times but rather the certain knowledge that sufficient lubricant of the correct kind and quality and free from dust, grit and all contamination is at all times being supplied to all bearings and moving parts.

Correct adjustment does not mean simply an occasional inspection to discover what might be termed major maladjustments. It means far more. It means also the constant daily attention and alertness of the operator to all and every indication of maladjustment of any part whether moving or stationary and its immediate correction. Thus the tightening of a loose bolt or a screw before any damage results is as much a part of this work as is maintaining the proper adjustment of the spark or the correct feed of the carburetor or the proper alignment and fit of the bearings. If these small or minor maladjustments are always discovered and corrected as soon as they become apparent to the inspection of the trained operator, the amount of delays to production from the necessity for making major adjustments and repairs will be greatly reduced.

The duty of the management is not only to provide proper equipment but also to see that this equipment is used both efficiently and effectively.

(To be concluded in December.)

THE PARTING OF THE WAYS

By W. W. CROSBY
Consulting Engineer, Coronado, Calif.

A City "Pairway" (with Street Car Reservation), Coronado, California

ACCORDING to a writer in Fortune Magazine, our expenditure of "15 billion dollars on our public roads, since the turn of the century, has brought us a highway system unfit for modern motor traffic."

Considering our rising annual traffic fatalities (over 3,000 per month now), and the evident trend toward higher traffic speeds, greater and more cumbersome traffic, and greater numbers of vehicles per mile of "improved" roadways, it is the opinion of the present writer, after an experience in highway work covering more than 40 years, that the statement quoted is not as extreme as it may appear. He believes, at any rate, that it will soon meet with general acceptance unless something radical is done promptly in the matter.

If we are still working with wrong ideals and standards, the hundreds of millions of dollars being spent annually on broad, smooth surfacings and on reducing hills and curves will only increase our dissatisfactions and make their removal more necessary and more difficult.

The Traffic Situation Analyzed

The normal increase of highway traffic has reached a point in many instances, and generally is approaching it, where relief from the insufficiency and danger so generated is undeniably needed. An analysis of the situation reveals these facts:

Speed is not simply a public whim. It is economy of time, and is an attribute of modern life. It is still developing in importance, though, as far as highway traffic is concerned, the curve is flattening off as it probably should. However, highway speeds cannot be narrowly limited nor unduly restricted without losses that will prove unacceptable.

Costs, for durable improvements, are of minor importance to the public, though obvious waste of public funds may still be quite another story.

Efficiency in our highways means to the public mind, "Convenience," and to that extent is important to all. The public relies on the trained mind to effect efficiency within convenience.

Three Sources of Highway Traffic Dangers

Dangers from highway traffic come from three sources: The car, the driver, and the road.

The manufacturers of cars have realized and assumed their responsibilities admirably. The driver still needs to be educated and impressed with his own individual responsibilities. Necessarily this must be left to the courts, the juries, and the police under the final authority of public opinion. A great deal may be expected from developments along this line, but the human factor will always exist.

The third source of danger is the road. A "blind curve," or an abrupt turn, or a too narrow pavement with "soft shoulders" cannot be convenient, efficient, or safe. Opposite-direction traffic in a single lane or track is, of course, most dangerous.

Our highway authorities have recognized and assumed their sole responsibility in the cases of some of these fundamentals. They are, in the main, no longer building roadways with too sharp curves for present-day speeds; too short sight-distances at intersections of lines or of profiles; and they apparently have a real mania now for "White Lines" and for abolishing grade-crossings of highways and railroads.

It is to these highway authorities that the public must look for the ultimate eradication of roadway dangers. The responsibility for the proper design of the highway to this end, so that the maximum advantages of the safe car, the educated driver, and the best possible roadway may be enjoyed by the nation, rests heavily with our highway authorities of the day.

The Ideal of the Broad Highway

The essential point that they have seemed to fail in grasping and on which hang all our hopes for a future escape from the catastrophe suggested by Fortune is *a new type of roadway is mandatory.*

It has been learned, both scientifically and experimentally, that when traffic reaches a certain amount, it is desirable, for many reasons, to segregate its conflicting elements. For twenty years or more the influences of the white line in this direction has been known. But the effectiveness of the white line is limited. Beyond its limitations, something more is needed.

Just where the white line fails, or under just what traffic conditions a substitute is required for it, depends on many factors. It suffices to mention here that it offers no physical obstacle to its being ignored. Its mental or moral obstruction to reckless drivers depends wholly on the "education" of those drivers.

Highway engineers have also known for some years that there was a limit to the widening of the roadway surfacing for the sake of efficiency under traffic and that, beyond a width of four traffic-lanes, the satisfaction with the roadway ordinarily decreased with its greater width.

Even four lanes have proved unsatisfactory in many cases. Also, a four-lane roadway, once finished, invites

roadside developments. Then there comes into the problem the conflict of roadside service with through-traffic movements. This decreases the efficiency and satisfaction and increases the hazards of the modern highway.

Here is where our highway authorities, with their "noses too close to the grindstone" of mileage production, have lost the proper perspective. They have idealized the four-lane roadway as sufficient for the traffic of today and tomorrow, and then they have allowed the car, the driver and the public to be blamed for the insufficiency and the hazards of their obsolescing road ideals.

A single roadway of four (or more) lanes cannot be now regarded as ideal despite white, or orange, or any lines along its surface; despite any improvements of cars; despite any possible education of drivers; and despite any speed laws, for a mixture of traffic in both directions of the roadway!

The sooner our highway authorities accept this fact, the better for all of us.

Separate Roadways Demanded

We have come to a "Parting of the Ways" in two senses.

Unless our highway authorities swing off now toward a new goal with new ideals, and if they continue toward the old ideal of the "Broad Highway," in the sense of a single, wide roadway for all traffic, we are doomed to disappointment, losses of life and limb in increasingly large figures, and ultimately, to excessive expenditures for the alternative.

In the other meaning of the phrase quoted above, we are come to the point where, in our highway improvement, we must divide physically the opposing traffic-streams by providing a separate roadway for each.

Every national highway should be a "Pairway." That is, it should, when finally completed, have a pair of roadways, one for traffic in each direction. ("Service roadways" may be added where needed.)

Every relocation of a state highway and every by-pass should be conceived as of becoming eventually a pairway.

In every case of improvement of a public road on which through-traffic may be regarded as a possibility, the pairway ideal should be cherished and only discarded when proved impossible of attainment.

And What About the Costs

Probably one of the first rejoinders to the foregoing will be that the costs of the new ideal would be too much. But, would they?

The pavement costs should be the same in either case

A "Pairway" Recently Built on State Highway No. 3 Near Oceanside, California

A "Pairway" on State Highway No. 3, Across "Torrey Pines Mesa," near La Jolla, California. Built a Few Years Ago by Then Supplementing the Old Pavement with a Separate New One Across City-Owned Lands. (Old Road on West Side)

as the areas need not be changed to secure the same capacities. It is true that culverts would have to be longer in most cases, and small bridges would have to be widened. In some cases the cuts and fills would have to be widened also. Except for some extremely long bridges or viaducts, the modern structures of this kind, occurring usually at long intervals only, could readily be fitted into the pairways satisfactorily, for an indefinite period, at little or no extra cost.

On the other hand, as the two roadways of a pairway need not be exactly on the same grades nor parallel in alignment, it is quite probable that considerable expense could be saved in the grading for a pairway from the cost for grading an equal width of single roadway. Even the ultimate expenditures for lighting may be reduced. There might be considerable savings—directly or indirectly—in the aggregate from the fact that, with the pairway ideal in mind, the actual construction of the second roadway need not always be done at the same time as the first of the pair. For a final conclusion now, let the reader refer to the remarks made earlier herein under "Costs."

Detailed discussion of all the advantages and disadvantages to be had from the change of Highway Ideals suggested is inappropriate in this article. But it may be pointed out that certain European countries (England, Germany and Italy), whose highway problems long antedate ours and from whom we have learned much in the past, have come to the reconstruction of their main highways along the new lines. One of our own States, New Jersey, has at last adopted the new ideal, the pairway, after more than 40 years' experience with highway improvement. The State of Washington, wisely "learning from the experience of others," has also adopted it.

At this season when sessions of many state legislatures are about to convene, it should be remembered that highway engineers and even the state highway departments often lack the authority to effect road improvement beyond a limited right-of-way. The maximum width of the latter is often fixed by law at too small a figure. Hence, consideration of the situation and preparation through the legislatures in the next six months for "Elbow Room"* in which to accomplish the desired results may save one or more years in getting out of the present mire. It is for highway engineers to press upward toward the goal.

*ROADS AND STREETS, Oct., 1934, p. 362, and March, 1936, p. 48.

General View of Bituminous Reconstruction Work September, 1936

THE MAINTENANCE PROGRAM OF WINNETKA, ILLINOIS

General Plan and Details of Methods Employed to Keep Pavements, Curbs and Sidewalks Continuously in Repair

By ROBERT L. ANDERSON
Superintendent of Public Works, Winnetka, Ill.

IT is perhaps somewhat trite to remark that maintenance begins when construction is completed, but failure to recognize or heed this fundamental fact is frequently the cause of short life or excessive maintenance costs of the various public structures that have become necessities in our modern existence. The demand for reduction of expenditures during the few years past has too often been the excuse for the false economy of elimination or drastic reduction of maintenance budgets. The immediate benefit of a painless cut in expenditures was usually more than compensated for by the complaints of the public a few years later when pavements began to disintegrate, sewers to stop up and public property in general to take on a "down at the heel" appearance.

Realization of the necessity of an adequate maintenance policy has grown up gradually in the Village of Winnetka, Illinois, a residential suburb on Chicago's north shore, with a population of 13,000. The Public Works Department of this village has charge of maintenance of all public structures and property with the exception of the municipally owned water and electric systems, which are handled by a separate department. Underground properties cared for include storm and sanitary sewerage systems and accessories, while the surface improvements consist of pavements and appurtenances, sidewalks, street trees, public buildings and other miscellaneous structures.

Sewers, pavements and sidewalks have all been constructed by special assessment against the properties benefited, but the theory that, once installed, maintenance of these structures is a general obligation has been followed uniformly. Accordingly the cost of all of the maintenance work described below has been borne out of general revenues with no direct assessments.

Pavement Summary

The village-maintained street pavement system consists of 43.3 miles of opened streets, paved as shown in the following table:

Concrete, brick and asphalt	28.9 miles
Tar and bituminous macadam	11.9
Cider and earth roads	2.5
Total	43.3 miles

Nearly all of the macadam and most of the brick pavements are over twenty years in age, running up to forty.

Placing and Spreading Material. Note the "Gauging Strips" in Position

Bituminous Pavement Resurfacing

For a number of years the Village has followed a policy of resurfacing macadam and some of the asphaltic macadam and brick pavements with a seal coat of tar and gravel every five or six years. This has tended to keep them in a uniform state of repair and appearance and has materially reduced the amount of patching required. This work was described in an article in the December 1935 issue of ROADS AND STREETS and is accomplished by the Village's own maintenance forces at an average cost of 6.5c per sq. yd. Occasionally a light prime coat of lighter tar covered with torpedo sand is used at a cost of about 3.7c per sq. yd.

In seal coating, tar is applied at the rate of ⅓ gallon per sq. yd. by truck distributors belonging to the company supplying the tar and covered by about 35 lb. of pea gravel, "tail-gated" on by the Village trucks. This provides for some excess gravel which is picked up by a mechanical sweeper after traffic has worked in all the tar will hold.

One hundred seventy thousand, four hundred sq. yds. of this work was done in 1934, 67,280 sq. yds. in 1935 and 26,200 sq. yds. in 1936.

Bituminous Pavement Reconstruction

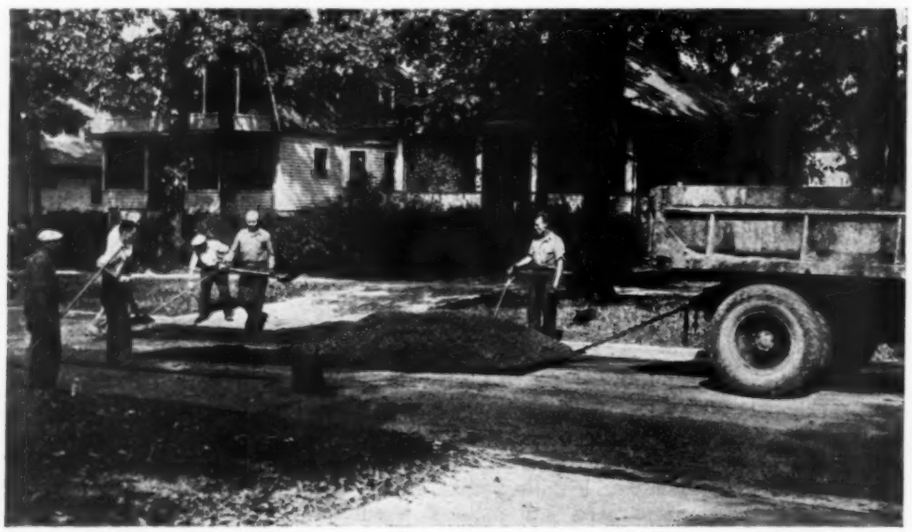
An important phase of pavement maintenance consists of the reconstruction of old bituminous macadam streets which, through settlement and traffic heavier than they were ever intended to carry, have become too rough to be benefited by the tar and gravel treatment. The program includes about a mile of this work each year.

In most cases it has been found that the old pavements provide a suitable base which has settled as much as it will, and accordingly it is covered with a single course of Tarvia-Lithic, a cold-lay plant-mixed product of the Barrett Company. Construction of a Chicago plant this year has made possible truck delivery to the job while the material is still warm from the mixer, although up to that time it was successfully handled after shipment by rail.

In this work, after curbing has been repaired and manhole covers raised to the new grade, the old surface is gone over carefully with a straight edge and patched with "fines" and rolled to as nearly an even contour as possible, the material being placed directly on the old surface without a tack coat. It is hauled about 24 miles from the plant in Ford equipment in 12 ton loads and dumped on two ⅛ in. x 6 ft. x 12 ft. steel plates from which it is shoveled into place by hand. In order to keep the material in the proper relation to the working face for most efficient handling, the plates are skidded along behind a truck, as shown in the accompanying picture. The leading edges of the plates are reinforced by a 5/16 in. x 2 in. x 2 in. angle welded to it with the legs down, and a steel loop of ½ in. plate is welded in the center, running back for 18 in. onto the plate for attaching the towing chain. As shown in the picture, the leading edge is raised a few inches off the ground in towing so that it skids easily even over rough spots or obstructions. Experience has shown that an additional 18 in. in the width of the plates would have been advantageous.

The final course is laid to a loose depth of 1¼ in., being placed by hand as above and raked to the proper depth and contour, using 3/16 in. x 1¼ in. x 16 ft. steel "gauging strips" or screeds for maintenance of proper thickness. These are furnished with an ell or tee at one end to make them stand on edge, and are placed at about 4 ft. intervals across the pavement, being advanced with the face of the work. As they are pulled forward, the track they leave in the placed material must be carefully filled and raked or it will persist in the finished pavement in spite of any amount of rolling. A few shovelfuls of the fresh material are thrown back on the track and thoroughly worked in before the excess is raked off. Because of this necessity it is well not to cover the strips for more than 5 or 6 ft. of their length before advancing them.

The work was started using 1½ in. strips, but a tendency to "push" under the roller suggested a reduction to 1¼ in. strips, which worked more satisfactorily.



Moving Loaded Dumping Plate Ahead

Bituminous Reconstruction Job After First Rolling

In the "fines" grade, used exclusively on this work, no aggregate is used which will not pass a ¼ in. screen, and if a thicker course is required, a coarser material is necessary. It should be noted that because the gauging strips always ride on the high spots, an average loose depth of at least ¼ in. greater than the strip depth is obtained. With the 1¼ in. strips the average compacted depth is about 1 in.

On a 21 ft. pavement a crew of 8 men has been found to be the most efficient, with 4 shoveling and 4 raking, one of the rakers doubling as truck driver as required for skidding the plates. This crew lays about 750 sq. yds. of finish course per 8-hour day.

Rolling of the patch work is done by a Village-owned 10-ton 3-wheel Austin-Western roller, but this was found to be too heavy for the final course, which is handled by a rented 6-ton tandem. In warm weather the finish course is rolled twice after placing, and two or three times again a day or two later. Ordinarily the street is opened to traffic after 2 days, but the surface is not damaged by passenger cars where there is no turning immediately after the first rolling.

The surface produced is gritty and has excellent non-skid qualities. In spite of the comparatively open texture and consequent porosity, close examination of sections that have come through several winters, including the severe one of 1935-36, has failed to show the slightest frost damage.

Costs of the work done this year were as follows:

		Per cent
Material	$5,173.49	82.0
Labor	907.74	14.4
Equipment	86.70	1.4
Rolling (rented only)	148.75	2.2
Total	$6,316.68	100.0

The total area completed was 9,502 sq. yds., making a unit cost of 66.4c per sq. yd. About nine-tenth of this work was done, using 1½ in. gauging strips, so the cost of a 1¼ in. job should be a little lower. The above costs do not include supervision and overhead but do include the adjusting to grade of 26 manhole covers, at an average cost of $5.00 each. Rate of pay for labor varied from 50c to 75c per hour, averaging 64c per hour.

The amount of material necessary for patching varies considerably with the condition of the old pavement, amounting to as much as one-fourth of the total weight in the case of a rough section. On one portion of this year's work, patching required 35.6 lb. per sq. yd. as against 131.5 lb. per sq. yd. for the finish course, or a total of 167.1 lb. per sq. yd. On a smooth section the patching will run down to about 10 lb. per sq. yd.

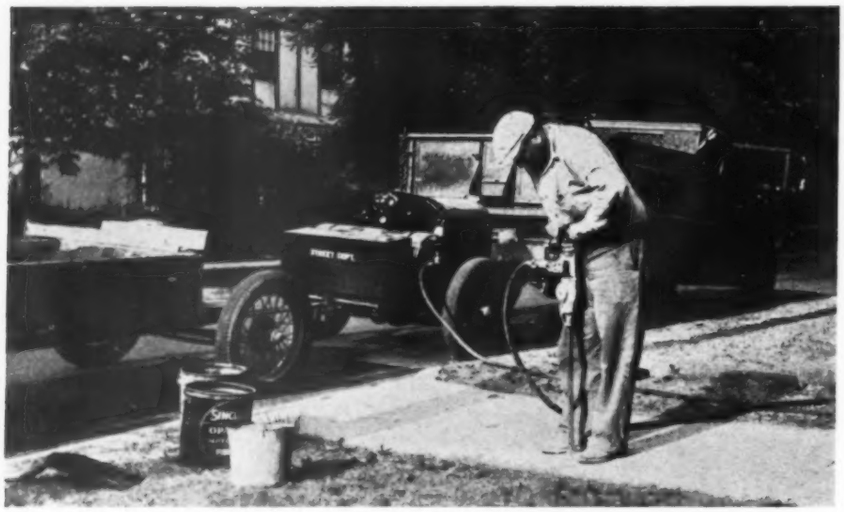
In former years this class of work was constructed as a two-course job, using a 2 in. (loose) base course of "intermediate" grade and a finish course of 1 in. (loose) of "fines." Where the old pavement provides a stable base it is believed the present procedure produces just as satisfactory and durable a job at about two-thirds of the cost. Naturally it can be completed more quickly and consequently with less inconvenience to traffic, and from the standpoint of the department more work can be accomplished in the time available.

The above described method of reconstruction offers the small community an economic means of producing a good job for the following reasons:

1. It requires no equipment but a roller and a truck and but few hand tools.
2. Uniformity of results is guaranteed by plant mix.
3. It can be handled by regular city crews.
4. Inclement weather, including rain, retards the set but does no lasting damage to the material, whether placed or in cars or other storage.

The only disadvantage noted is that it is a hot, or at least a warm weather material. Unless arrangements for heating can be made, work should not be attempted in temperatures under 65° or preferably 70°, as it becomes too stiff for proper handling.

The Mud Jack in Operation



Drilling Slab for Mud Jack

Routine Pavement Repair

The usual annual patrol of all pavements is made at a cost of about $2,000. All cracks are sealed with tar, incipient holes in macadam are repaired with crushed stone and tar with a surfacing of pea gravel, and conditions indicating subgrade failures are reported. These are corrected in the case of concrete pavements by the use of a mud-jack, as described later. Because much of this class of pavement was built in swampy ground in which settlement is unavoidable, this work is important.

Curbing

The program includes the replacement of about 2,000 ft. of broken curb each year and the raising to grade of a further substantial amount using the mud-jack.

Sidewalk Repair

There are some 63 miles of public concrete walk in the Village, much of which is from 25 to 40 years old, of weak construction, and accordingly in poor shape. A five-year program is in progress, in the course of which all this walk will be repaired, using the mud-jack first to bring all sound slabs to grade and following up with a concrete crew to replace the broken sections.

The mud-jack work has been in progress now for two seasons, with gratifying results. Costs have averaged 3.5c per sq. ft., as compared with 15c per sq. ft. for the same work as formerly done by hand, or about 20c per sq. ft. for replacement.

The outfit consists of a truck for hauling dirt and moving about, a trailer "mortar box on wheels" for mixing the dirt, a small compressor and jackhammer for drilling the holes, and an NEC Model 10 Mud-Jack, which is much smaller than the more familiar machine usually used on pavement work.

The trailer was constructed in the Village shop from an old Ford chassis at a cost of about $35. The compressor likewise is a home-made one, being a Ford Model A engine converted by the use of a Smith compressor head to drive on 2 cylinders and compress on the other 2, and is mounted as a 2-wheel trailer. It has been highly satisfactory for this purpose, handling the Ingersoll-Rand rotating jackhammer with ease, and was constructed at a cost of $383.

The dirt used is a screened black loam to which is added a small amount of cement for drying purposes. It happens that the dirt is available in unlimited quantities at the Village dump.

A crew of 3, or preferably 4, men is used, one drilling the holes, one operating the mud-jack and one or two mixing and hauling dirt and cementing up holes after completion of the work. This crew can raise from 100 to 300 lin. ft. of 5 ft. 4 in. width walk per 8-hour day, depending upon its condition. It should be remembered that this is in sections of 1 or 2 or 3 slabs at a time, and a day's work may extend over half a mile of walk. Mobility of equipment is therefore important. In the absence of the truck, as in hauling dirt, the trailer and compressor may be easily pulled by two men.

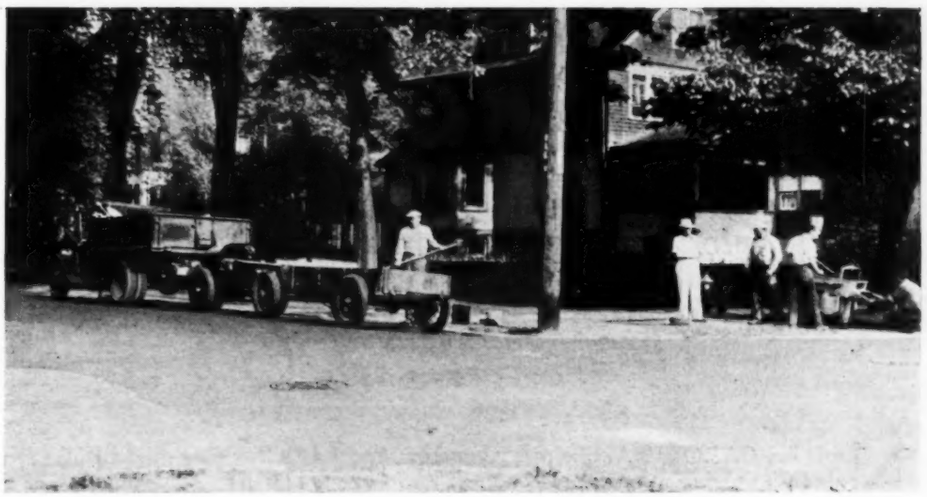
The chief difficulty encountered has been by reason of the construction of the old walk, which did not provide for joints to be cut clear through, and which consequently makes it difficult to raise a slab without bringing up the adjoining one with it. This problem is solved by cutting the joint through when necessary, using a thin cutting tool in a pneumatic spader.

This class of work has produced excellent results and is felt to be a great contribution in the maintenance of concrete walks. It corrects the subgrade fault which is causing the trouble, and after a little experience a crew can control the "raise" remarkably well. As indicated above, combined curb and gutter and concrete pavements are raised with the same outfit, although for the latter a larger jack is more suitable.

Cutting Through a Joint of Old Walk

Following the mud-jack, a concrete crew replaces the slabs that were broken up. Since these also occur in small scattered sections, mobility is again of prime importance, and the customary two-course job, with a lean base and thin wearing surface, is unsuitable, as it would require the mixer to turn to pour the "topping." Accordingly, a 1:2:3 mix single course slab is poured, the labor saved more than compensating for the extra material cost.

The crew consists of 6 men. Two work ahead,



Sidewalk Jacking Crew at Work. Truck, Compressor and Mortar Box Trailer in Tandem—Mud Jack at Right

breaking out old walk and setting forms. Two more mix and place the concrete, while the last two finish. The mixer is a Jaeger Tilter, 3½ cu. ft. capacity 2-wheel trailer type. Materials are charged into it directly from the truck, which loads aggregates and cement in approximately the proportions required.

This outfit averages about 60 lin. ft. of walk per 8-hour day at a cost of $1.02 per lin. ft., or a little less than 20c per sq. ft., and a considerably stronger job is obtained than is usual. Something over 3,200 lin. ft., mainly in sections of 5 to 15 ft., has been so replaced this year.

As noted above, this same outfit also replaces broken curbing, with the exception that a compressor is used in addition for breaking out the old curb.

Street Openings

It is believed in Winnetka that an important part of any maintenance program is a close supervision over openings in the street for utility services and repairs because it is found that a large part of all repairs are caused by settling of these openings. Accordingly permits are required for all street openings and are granted only when absolutely necessary.

All backfills are made by the Village and charged to the applicant, to insure care in backfilling.

While maintenance of public property is not spectacular, as is construction work, it is nevertheless just as important to the life and cost of the property. The public will be well repaid for careful attention to maintenance problems.

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410 Miles Cotton Reinforced Surface to Be Completed This Year

More than 400 miles of cotton reinforced bituminous surfaced roads will have been completed in ten states before snow flies, according to reports reaching the Cotton-Textile Institute from state highway departments. Completion of the roads for which the cotton fabric, used as a reinforcing membrane between top-surface and base, was furnished gratis to the state by the Federal government, will insure, the Institute points out, a broad scale demonstration of the practicability of such roads under varying extremes of winter weather and traffic.

Tabulation of the reports shows that 410½ miles of roads are completed or under way, including the following: New Hampshire, 2 miles; Rhode Island, 12 miles; Massachusetts, 4 miles; New York, 100 miles; New Jersey, 10 miles; North Carolina, 105 miles.

Stabilized Road Construction in Illinois

On Jan. 1, 1836, the Illinois Division of Highways, as a part of its program for the construction of low cost secondary roads, had completed a total of 309.65 miles of stabilized gravel and crushed stone surfaces. An additional 55.71 miles was placed under contract for construction during 1936, this mileage being confined largely to locations where materials can be obtained locally. Of the mileage built prior to Jan. 1, 1936, 15.65 miles were further improved with a bituminous surface of some sort and the 1936 program includes the placing of 86.77 miles of bituminous surfaces on stabilized bases.

A soils laboratory has been established by the Bureau of Materials in Springfield and branch laboratories equipped to make routine tests have been established in the several district headquarters. These laboratories will not only perform work connected with the construction of stabilized surfaces but also general soils work, such as the treatment of subgrades, analysis of embankment materials, and the study of drainage problems.

A series of bulletins on soils and drainage work are being issued by the Bureau of Materials for the field engineers engaged in this work. These bulletins are intended to acquaint the engineers with the properties of soils and the latest developments in soils work.

The bulletins issued to date cover the following subjects:

1. Announcement and outline of subjects to be discussed in ensuing bulletins.
2. Correction tables for the hydrometer analysis.
3. Soil, soil forming processes, geological classifications, soil materials, chemical composition, color of soils, organic matter of soils.
4. Texture, mechanical analysis, textural grouping.
5. Characteristics of soil separates.
6. Classifications of field tests, classification chart.
7. Structure, structural classification, granulation, structural terms.
8. Specific gravity and actual weight of soils.

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HIGHWAY SIDEWALKS RECOMMENDED. We are informed that the State Planning Boards of New Mexico and Utah have recommended in their reports that highway sidewalks be constructed. Such "walkways" are held to be particularly needed on the highways which provide entrance to a city.

MOTHER NATURE TEACHES ENGINEERS A LESSON

Winter Damage to North Carolina's Surface Treated Roads

By JAMES S. BURCH

Engineer of Statistics and Planning,
North Carolina State Highway and Public Works Commission

NORTH CAROLINA, like many another state, has been indulging in an examination of its secondary road policy, following the ravages of the past winter. Most unexpected to the modern motorist was the experience of uncomfortable roads, highways potted with holes, and special load limits on trucks. Nor were such phenomena fully expected by the engineers in the state highway organization.

Shakespeare coined the applicable axiom, "Sweet are the uses of adversity." From this viewpoint, the losses of the past winter are undoubtedly real blessings, in that they bring back to us certain recognized fundamentals, point out our weaknesses in design and procedure, demonstrate that physical laws must be obeyed, and clearly indicate to the public the result of extremely low maintenance budgets.

The Beginning of the State Highway System

North Carolina was among the first to envision and execute plans for a statewide improved highway system, and was a leader in the completion of the major phase of construction of her system.

As early as 1921 a 5,500 mile highway system was selected, a gasoline tax was levied, and a fifty million dollar highway bond issue was made. By 1927 highway bonds had been issued to the extent of 115 million dollars, and with the aid of increased revenues from gasoline tax and license fees and with Federal aid, the state, by the end of 1928, had been able to provide, without any property taxation for state roads whatever, a 7,550 mile system of improved highways connecting all county seats and principal towns. The system at that time was 49 per cent paved with rigid type surfaces, and 70 per cent of the system was surfaced with some dustless weatherproof type. It is believed that North Carolina's record of construction during this period was outstanding in the United States, both from the standpoint of mileage and quality of improvements, especially in view of the large area of the state per million population.

As the primary arteries of the state highway system became paved with high-type surfaces, there developed an insistent demand in all sections of the state that the entire system should be rendered dustless and weatherproof by means of some form of "hard surface," and constant demands were prevalent for the extension of the system.

Lacking funds for such an intensive improvement and for such widespread extension of the state system with high-type paving, the bituminous surface-treated road came into usage, first as an experiment, next as an expedient, and after a few years as an established policy for the surfacing of secondary arteries of the state highway system.

Original "Rules" for Surface-Treated Type

During the early considerations of the surface-treated type, technical knowledge was limited to the conditions, materials and methods peculiar to the type. At the same time, however, certain basic limitations were recognized and care was generally exercised to avoid overtaxing the minimum factor of safety inherent to the type as a low cost class of road. It was recognized that:

First, the grading (fills) should be well compacted, and that ultimate settlement should have taken place prior to treatment.

Second, the sub-base (sand-clay, gravel, etc.) should be of such material, thickness and condition as to adequately accommodate the expected traffic for a short period without the surface treatment. (However, not until recent years had it been learned that a relatively high clay content might be satisfactory for an untreated condition, but unsatisfactory for a treated condition, due to loss of evaporation.)

Third, that adequate drainage should be provided, both by structures, wide ditches, interception of seepage, and otherwise, to provide a permanent, stable sub-base, even in wet weather and under thawing conditions.

Fourth, provision should always be made for periodic re-treatments at intervals not longer than three to four years.

Fifth, adequate and constant maintenance should be provided.

These were the original "rules," and experience has proved that they were generally safe rules when followed. Although basic improvements in technique and procedure have been effected, these are still fundamental rules for the type.

The recent lesson indicates that had these rules been closely followed, the recent winter would have in no wise developed the extent of damage which has been experienced.

A Development of Depression Conditions

The failure to follow the known rules and improved technique in all cases may not be fully attributed to any one cause, or to any group, or to any single part of the highway organization. This situation was a development of depression conditions, bringing about an enforced general laxity toward the known basic engineering requirements.

The demands of the public were insistent, the mileage was constantly being increased, and available funds were limited. The tendency and pressure was to constantly spread out the available funds, postpone retreatments, hope the sub-base and surface were satisfactory, and trust that failures would not occur. Nor is North Carolina alone in this experience. It is probable that half

the states are learning the same type of lesson, due to the same basic causes.

A study of conditions and expenditures for maintenance and betterments in this state indicates that the period including fiscal years 1929 and 1932 might be considered as approximately representative as regards needed per-mile expenditures for surface-treated types on the state highway system. During these years the surface-treated mileage increased from 1,400 to 2,160 miles, and this type represented from 18.5 to 21.5 per cent of the mileage on the system. In January of 1932 there were 267 miles of the type which had been treated for the first time during the then previous year; there were 485 miles not more than two years old, and 758 miles not more than three years old. With this new mileage and the 1,400 miles of the type previously under maintenance in 1929, it would be expected that the annual expenditure for proper care of the mileage during 1933-34-35 would have increased materially, at least in proportion to the increase in the mileage of the type. The record, however, shows the reverse to be true. We find that betterment expenditures (for all types and purposes, though generally for retreatments) and the mileage of surface treated types on the state system were as follows:

Fiscal Year	Betterment Expenditure (000 Omitted)	S-T Mileage on System (State)	*Betterment Expenditure Per Mile
1929	$ 806	1403	$574
1930	1434	1675	856
1931	885	1894	467
1932	918	2161	425
1933	213	2364	90
1934	559	2527	221
1935	268	2911	92

*Note—(Figures in this column do not denote that all betterments were for surface-treatment work, although this was generally true. The figures, per se, have no meaning, but the trend from year to year per mile indicates the lowered level of improvements and infrequency of retreatment.)

The above table shows that the average index for the period, including 1929 and 1932, is $580, while for the later period it is $134. The later period index was only about 23 per cent of the rate for the previous period. This percentage is significant in that it indicates that about *three-fourths of the needed retreatments and improvements were not made* during the three years prior to the recent disastrous winter.

From other data we note that betterment expenditures during the 1929-32 period were over 35 per cent of the total maintenance bill per mile, while this figure was only

Fig. 1—Weakened Section of Surface-Treated Sand-Asphalt Road Handling 650 Vehicles per Day Average, 27 per cent Trucks. Note Windrow of Mixed-in-Place Sand on Left Ready to Be Spread Over Surface.

Fig. 2—Section of the Road Shown in Fig. 1 Which Weathered the Winter Without Damage

about 15 per cent during the more recent period. There is no doubt that needed retreatments and improvements were generally postponed and avoided during this period of retrenchment and fiscal stringency.

General studies indicate that on the basis of retreatment being needed every three years at about $1,000 per retreatment mile, the deficiencies on this item alone during fiscal 1933-34-35 will total about 2 million dollars on the state highway system. (During the same period diversions of one million dollars each year have been made from the highway fund to the general state fund. This statement is not presented for discussion but as a fact relative to this subject.)

present revenues of the Highway Commission are barely adequate for the debt service and the maintenance of the highways with only a scant margin for construction and betterments. There is no surplus that can be diverted to general fund purposes, nor can maintenance costs be safely reduced lower than the experimental reduction placed into operation in November, 1932. Any further diversion of funds will place the Highway Commission in a position where it cannot satisfactorily perform the task of maintenance of all the highways of the State. . . ."

The general assembly of 1933 diverted one million dollars per year to the general fund and, fearing the effects

Fig. 3—Section of Surface-Treated Highway Handling 500 Vehicles per Day, 20 per cent Trucks. Failure Occurred Here Due to Poor Drainage (Ditches Lowered Since Failure Developed) Base High in Clay Content, But Would Have Withstood Winter Except for Poor Drainage

Fig. 4—Another Section of Road Shown in Fig. 3 Well Drained, No Damage, Low Maintenance Cost, Satisfactory Service.

Dangers of Inadequate Maintenance Realized

That the state highway commission was concerned with the dangers of poor maintenance and apprehensive of the high ultimate cost of deficient expenditures is indicated in the following extracts from the biennial reports of the chairman to the governor.

In the report of Mr. E. B. Jeffries, December 1, 1932 (3½ years ago), ". . . further burdens must not be placed upon the highway funds at this time. . . . the roads cannot be neglected. The investment must be protected. . . . Good maintenance is economy in its every aspect . . . of the economic crisis, limited annual expenditures for maintenance *and* betterments of the state system to the equivalent of about $160 per mile. ($900,000 urgently needed later added by executive order.)

The revenues increaed above estimates, expenditures for construction had been almost wholly suspended, and at this enforced low expenditure for maintenance a sizable surplus developed, amounting at July 1, 1935, to over 9.5 million dollars. In anticipating this surplus in January of 1935, Chairman Capus M. Waynick stated in the Tenth Biennial Report:

"This surplus has accumulated at the expense of the users of the utility for which the money was paid into the State, and the State as a whole through the deterioration of the road system. The withholding of this money from use . . . has prevented the kind of maintenance essential to public service and the protection of the State's investment. *The continuance of the policy of inadequate maintenance would not be long in bringing about a condition of disrepair with which the State could cope only at extraordinary expense. The inadequacy of the present maintenance provisions is not realized fully by the public as yet,* although complaints about the condition of the roads pour in. The engineers and other agents of the Commission *know that deterioration of the roads for another two-year period of similar maintenance would be disastrous."* In these words Chairman Waynick all but dated the breakdown, which came twelve months later.

The survey made in late 1934 by the engineers showed that about six million dollars would be necessary to restore the North Carolina roads to their 1933 summer (normal) condition, and that of this amount, 2.057 million dollars was needed at that time for retreatments. This latter figure corresponds closely with the results of our study previously indicated and represents the "deficiency in expenditures for needed improvements on the state highway surface-treated roads."

Now, following the ravages of the recent winter on the inherently weakened system, according to the best available estimates,* about 1.8 million dollars is being needed currently to recondition and retreat the surface-treated sections on the state highway system and restore these sections to good, serviceable condition. It is not inferred that this entire amount resulted from the winter's damage; rather, a large part of this amount represents the "lag" in needs not fulfilled with respect to this type. Although reconditioning and retreatment work is being rushed on practically all damaged sections, it appears physically and financially impossible to complete all the needed work under specification requirements prior to the coming winter.

The "Bad Roads Tax"

The above discussion indicates the poor economy of inadequate expenditures from the standpoint only of the state highway commission. In addition there is a direct loss to the highway users resulting from such a policy, and in the final analysis, the effect on the user should be given primary consideration. It may be reasonably estimated, using logical values and operating costs, mileages, and effect on operating cost of bad roads, that during the six months' period from December 1935 to June of 1936, the increased cost of vehicle operation in North Carolina attributable to the poorer conditions of the surface treated mileage on the state highway system is at least 2.5 million dollars, without including the extra-miles traveled on detours and the losses through non-use by trucks of restricted sections.

In one sense, this figure might be considered the special "bad road tax" which the vehicle operator paid during these current six months on the state system surface-treated mileage alone due largely to previous false economy. The extent of "non-use" of roads is indicated by the fact that, for the first quarter of 1936, gasoline consumption was about 9 per cent below expectancy.

The engineer, the economist, and most laymen realize the fact that savings in upkeep expense, below an adequate level, represent not savings, but waste, and partial abandonment of plant, and yet, most legislative bodies are prone to pare budgets below this economic level in order to indicate a "saving," however temporary this "saving" may be. Every vehicle owner knows that he can "save" a dollar a month on his car's oil bill, but he also knows that he will pay dearly for this practice in heavy repairs and depreciation. There is an old adage that you can successfully deprive the horse of food, even though he dies from starvation. In spite of these well recognized principles in farm, industrial and home management, the representatives of the people have difficulty in grasping the significance of these economic laws.

If the experience of the recent winter is not too soon forgotten, these losses may represent an excellent reminder to the people and their representatives for years to come.

Our engineers and officials fully appreciate the limits and weaknesses of the surface-treated type. At the same time, we have about 6,000 miles of road on the state system on which we cannot afford the investment in high-type pavement but which must be kept in serviceable condition for traffic. Surface treatment appears to be the best and most economical expedient for a large part of this mileage. Logical procedure, therefore, indicates the continued use of the type of secondary highways but requires that the known "rules" and limits of the type shall, in the future, be implicitly respected.

Causes of Damage Analyzed

A diagnosis of the causes of the damage to surface-treated roads develops the following reasons in order of importance, together with brief discussions as to these causes and plans for improvement and correction.

1. *Excessive Clay in Base Material. (Sand-Clay, Gravel, Topsoil, Etc.).*—Materials encountered under surface treatments on examination varied from excellent to definitely unsuitable. Test results on hundreds of samples indicated that in a majority of cases base materials were of poor quality, usually exhibiting either high plasticity, poor grading, high capillarity or extreme expansive properties. Through laboratory tests on soils, poor clays are being rejected or improved by admixtures. Likewise the thickess of the base material is being adjusted to needs from point to point. Our soil laboratory now selects materials for bases according to test results recommended by the U. S. Bureau of Public Roads. Chairman Waynick and Chief Engineer Baise are the first of our officials to recognize the importance of rigid laboratory control of soils and to install this modern method of control. Marked improvement has been noted and may reasonably be expected in the service of roads built and reconditioned on this basis.

2. *Inadequate Drainage.*—Limited graded roadway widths have often prevented the use of adequate side ditches without creating traffic hazards, and in many such cases water standing level with road edges has been noted, saturating the sub-base and precipitating failures under traffic. Water bearing strata not intercepted develop the same result. Current efforts are directed at the obvious and ancient remedy—"adequate drainage" to keep water away from the base.

3. *Poor Grading (Earth).*—In many cases, the natural earth has exhibited such adverse properties on examination as to make it inadvisable to place surface treatment closer than 18 inches above the earth-work grade. Worst offenders are impervious A-6 and A-7 clays, which exhibit high expansive properties and which become unstable in the presence of appreciable moisture. The local names applied to these types of soil are "pipe-clay," "Bull tallow," and "gumbo." Current efforts are directed at removal or avoidance of these soils near the surface or by raising the grade with suitable material prior to treatment. Soil testing is likewise employed for the

*By virtue of the nature of the damage, estimates may not be accurately arrived at for many months, the damage being of a kind which does not quickly disclose its full effects.

detection of these materials and for recommendations as to their disposition.

4. *Lack of Retreatments When Needed.*—Failure to retreat at about three-year intervals has permitted the surface to lose its vital properties of flexibility, ductility and resiliency, developing a dead, brittle mat which cracks under traffic, fails to reseal and permits the entrance of surface water followed by softened base. Freezing and thawing develops progressive disintegration, and traffic imparts the final destructive force. The remedy is obviously a definite planned retreatment program with sufficient funds earmarked in advance for this purpose. Retreatment at needed intervals imparts new life to the original mat, seals forming cracks, and renews the desirable qualities of the original treatment.

5. *Heavy Traffic.*—Although no applicable data are available in this state on wheel loads and volume of heavy vehicles on given lengths of road, it is generally believed that the average surface-treated road accommodates many more vehicles and heavier vehicles than ever before. This is the logical result of road development. The fact that traffic increases do not appear to have been forecast or really anticipated in the past has led to considerable damage in that many sections have been overtaxed by traffic. A statewide transport survey, now being initiated, has as one of its objectives analyses and forecasts of type, volume, weight and class of traffic. Such data should represent the basis for future improvements on the system.

General Observations

On all these considerations we observe the importance of adequate funds. It is true that the engineer should be expected to make the dollar go further than the average man. But even the engineer is no magician, and when he attempts to accomplish the impossible in stretching the dollar he injures his professional and technical reputation, as well as the record of his organization. Likewise, economy is the essence of good administration in public office. However, true economy may be attained only through adequate expenditure and funds, more or less than adequacy represents waste. The forces of nature may be resisted, but adequate resistance requires adequate funds in addition to skilled supervision. North Carolina, a pioneer in highway transport, has learned another lesson in the hands of Mother Nature.

COUNTY ROAD GRADING IN MARYLAND

Before

Road No. 1 *in Prince George County*

Road No. 14 *in Wicomico County*

After

Road No. 1 *in Prince George County*

Road No. 14 *in Wicomico County*

CENTER-LINE CURBS FOR HIGHWAYS

By MURRAY D. VAN WAGONER

Michigan State Highway Commissioner

THE Michigan State Highway Department is experimenting with a newly developed center-line curb as a means of insulating opposing streams of traffic from one another. The application has been to 4-lane highways and to certain complicated situations on other roads. To date the results have been so encouraging as to make the method a matter of interest to highway authorities who must cope with the dangers which hitherto have been inherent in these types of roadway.

In its present form this center-line curb consists of a strip of asphalt 12 in. wide and from ¾ to 1 in. thick laid on the pavement surface along the line where it is desirable to separate or guide traffic. It is, of course, a warning to the driver and not an obstruction to the vehicle. To emphasize the warning, we paint a 6-in. yellow stripe down the center of the strip and on the pavement surface at its edges, 4-in. yellow stripes. The result is a stereoscopic effect which makes the curb appear to be about 3 in. high.

This device was first tried out at a particularly difficult point on US-10 near Birmingham, Michigan. Here, due to difficulty in securing right-of-way, it was necessary to postpone construction of a short section of one of the twin 44-ft. roadways on which US-10 traffic travels through this densely populated suburban section. In consequence, both north and south bound traffic had to be routed over one roadway and a very serious danger spot developed.

With a combination of pavement signs and arrows with a center line curb we have succeeded in controlling and guiding heavy traffic safely through this accident zone.

Our success in this instance led to trying the same methods at the junction of M-21 with a former route of the same trunkline near Zeeland in the western part of the state. The accompanying plan indicates the traffic problem there and the means which were adopted to solve it. A feature of the terrain which is not shown on the drawing, but which greatly complicated the situation, is a sharp hill which hid cars approaching the intersection. The advantage gained by our control measures was in bringing cars entering the main highways across the opposing traffic lane at a right angle, thus cutting the danger zone to the minimum.

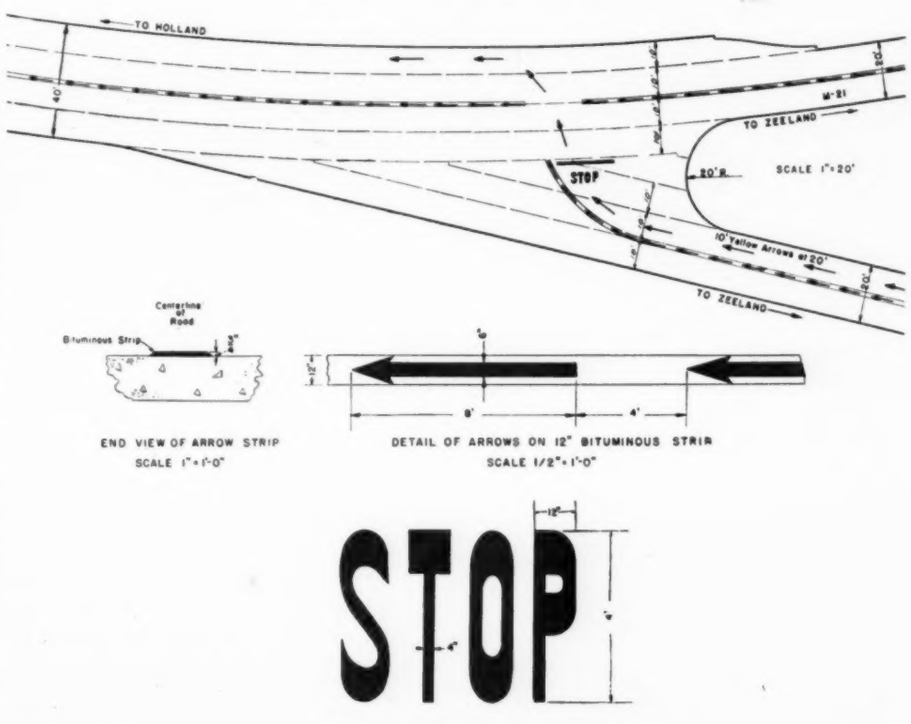
Other points where we foresee a logical application of the center-line curb in keeping traffic on the proper side of the road are curves and hills. But, as the name indicates, we consider it especially suited for separating the two streams of traffic on 4-lane highways.

However, this is probably not the final form in which the center-line curb will be used in Michigan. The state highway department now has a further development of it in the drafting-room stage, which will change radically both its structure and its method of traffic control. The new curb will be of heavy sheet metal, formed with a 6-in. base and side rising 3 in. perpendicularly to a rounding top. Its total height will be 6 in.

This metal curb will be installed on US-23 between Bay City and Saginaw, where the highway follows the river closely with several dangerous curves. It is hoped and expected that the new curb will cut the present accident ratio on this highway materially.

We now have a section built on US-10 north of Pontiac. It is only 2,500 feet long and its use here is entirely experimental, but the public reaction to it has been almost unanimously favorable.

A cross section of the curb in its present form is shown on the plan. As a first step in constructing it, the pavement surface is cleaned off with carbon tetrachloride. Then the curb is moulded into shape with the aid of a special templet. The bituminous material used is a commercial product prepared for patching. The cost is about $500 per mile.



Detail of Cross-Over on M-21 West of Zeeland, Michigan, Showing Also Center-Line Bituminous Strip.

PAVING FAILURES AND SUBGRADE TREATMENTS

Highway Engineer Says Lesson Has Been Taught But Not Learned

By H. H. HOUK
Chief Engineer,
Alabama State Highway Department

SINCE the writer is comparatively new in the roadway branch of highway engineering, his thought and his expression may be said to be influenced to a degree by lengthy service as a structural engineer, where the experience and training is to obtain adequate support from the beginning and build from the bottom upwards to resist all forces, including those forces of nature peculiarly active in the locality where the structure is built.

As a bridge engineer, casually observing roadway construction for two decades, he had until a few years ago entertained the popular opinion that, given enough money almost anyone could build a good road. However, after accepting the responsibility for engineering the highway work in his state, he has been forced to the conclusion that the majority of the examples of successful wearing surfaces or pavements in service have resulted, more from favorable natural conditions than from intelligent engineering design. Until recently there has been little more than an approach made to the solution of the real problems involved in the construction of an economic and durable wearing surface in any but localities with the most favorable natural conditions. Anyone in doubt of this had only to spend a few weeks of careful observation and study of the real condition of several thousand miles of the highways of the nation as the writer did following the "spring break-up." The extensive damage suffered by the roads of the country during the past winter constitutes a mute but serious indictment of the efficiency of the highway engineering profession as a whole.

The public can not fully realize the extent of highway deterioration and disintegration evidenced by the past severe winter. The writer doubts that many highway engineers yet realize the real weakness of the basic elements of the average highway as it has been built. In most cases the past severe winter was not the sole cause of the damage (and there will be more of such winters with increasingly greater damaging effect). It merely accelerated the deterioration and disintegration already in progress and emphasized the evidence of defective design. That the extent of the breakdown is not widely realized is evident, because some engineers have serenely covered up the damning evidence with coatings and treatments, many of which at the best can be but temporary in effect. Some highway authorities, to cover their shortcomings and save their political sponsors, have thrown additional "good money after bad," covering up the evidence under the guise of maintenance. These failures cannot be simply explained away or justified by the plea that low cost or economy methods dictated the design. Some of the explanations given for failures appear ridiculous in the light of actual investigations. It requires considerable courage for an engineer or a highway department to face the criticism that comes when a highway failure is torn up and rebuilt, but much of this reconstruction from the subgrade up must, in the end, be done before dependable, durable highways will be obtained.

The highway industry demands better engineering. The demand is so great for roads, and with diversion added, the motorist's ability to pay is becoming so limited that highway engineers must learn how to build better roads, roads designed to withstand weathering. Each highway is first of all an engineering structure that must be designed from foundation to roof as an individual structure for the particular locality in which it is situated. As such it is exposed to all the local weathering and disintegrating processes of nature, and since it is expected to have an economic service life, these forces of nature often prove to be greater and more important factors in the design of the pavement and its support than the action or volume of traffic. All too often the number of vehicles per day has been accepted as the controlling factor in the selection of the type of pavement.

Most of the failures can be tracted to failure to study and understand natural phenomena. Nature's laws must be studied and followed to obtain the assistance of their beneficial actions and avoid the effects of their detrimental actions. Man cannot arbitrarily lay down a pavement structure, thin as the thickest are, exposed and subjected to the effects of the climate and the chemical action of injurious soil water, and expect it to survive the forces that in time level mountains of granite. All engineering construction materials undergo some change with time. Durability is a relative term, but road builders should know whether or not the probable physical and chemical changes in the materials used will affect the economic life of the road.

The major damage has been due to the failure of engineers to protect the elements of the road structure, the subgrade, the foundation and the surface from the injurious effects of the action of water, by side drainage, subgrade drainage, foundation drainage, and from the harmful capilliary action of soil waters. Instances of bad drainage due to low grade lines and high water tables are apparent almost everywhere, especially in irrigated sections and in regions of heavy rainfall.

Any type of pavement or wearing course to be successful must be placed on a sound, stable subgrade, or it must have a base or foundation course thick enough and stable enough to deliver the loads transferred by traffic from the pavement or wearing course to the subgrade in a manner that will not overtax the supporting power of the subgrade in its weakest condition. The theoretical methods advanced to determine the required thickness

Showing Failure to Concrete Pavement Because of Non-Uniform Subgrade and Lack of Drainage

of pavement have no application where the supporting soil and its characteristics vary.

Small increases in the moisture content often greatly reduce the supporting power of subgrade and base course material, especially certain types of subgrade clay and clay binder material. This has led to many failures in the low cost field. Many engineers and road builders, observing the successful use of bituminous surfaces on certain examples of old gravel or similar surfaced roads, have experienced failure on attempting the bituminous surfacing of other such roads having insufficient base thickness, poor drainage and excessive clay content, due to the softening of the base and subgrade and decreased evaporation.

Other failures have resulted from constructing base courses or foundations of the material containing excessive amounts of clay binder, chiefly because such material had proven satisfactory for gravel or similar unsurfaced roads and because similar old gravel surfaces had been successfully treated. However, these old gravel surfaces that were successfully surfaced in many instances had become stabilized with time, during which a large percentage of the harmful binder removed by traffic, the elements and capillary action. Rapid failure of the low cost bituminous types follows base failures. Attempts at low cost construction on inadequate bases have proven expensive and have retarded the development of such types. Rigid type bases or pavements of conventional design and thickness will not survive unless placed on a uniformly rigid or uniformly elastic foundation, that is one having uniform supporting power. Many soils are entirely unsuitable for the rigid type of pavement. In fact, there can be no truly rigid pavement except one having artificial support such as one on a bridge slab or one on a base thick enough to constitute a foundation in fact. Fortunately the natural soils in some localities are so uniform in composition and provide such uniform support that they will satisfactorily carry pavements of the conventional theoretical design. In these areas pavements are almost uniformly successful, unless of faulty design or construction.

However, in many sections of the country the roadbed soil in its natural state is either too unstable or too weak under certain climatic conditions to support the load. In such cases an adequate foundation must be provided either by stabilizing the natural soil through the use of natural materials or chemicals or by providing a foundation or base course, or both. It is in such sections that failures abound and where every effort should be exerted by the engineers responsible to improve quality of engineering.

Rigid base and pavement designs, adequate and successful on favorable natural soil subgrades, have often proven costly, short-lived, and failures when placed on subgrade soils varying greatly in stability or composition. On some of the most unfavorable subgrades thin, flexible pavements on stable foundation courses of selected local material have proven more economical and, in some instances, more durable than the so-called higher types. In some localities the durability of the rigid pavement in contact with the soil of the subgrade is uncertain. Many cases can be cited where such pavements, though well designed and constructed, have undergone severe deterioration and disintegration as result of obscure chemical reactions. The burden of reconstruction of what was built as a bonded improvement becomes a severe burden on the taxpayers. It would be impracticable, if not impossible, to ascertain the possible chemical reactions resulting from the capillary action of soil water passing through mixtures of some soils and the probable effect of these reactions on Portland or bituminous cement or other paving materials during the expected life of an expensive pavement.

In rolling country, especially in the coal regions, many different kinds of soil are often excavated from a single cut and placed indiscriminately in adjacent fills. Each combination of soils is affected to different degrees by variations in moisture content. Neither artificial methods nor reasonable time itself will so compact these fills that some unevenness in the surface will not result due to subsidence, settlement, shrinkage or distortion or combinations thereof. Only where the soil is reasonably uniform in character and behavior from cut section to fill sections do uniform subgrade conditions exist.

Fortunately it is usually practicable to provide a stable subgrade base or foundation course of adequate supporting power through the use of suitable selected materials, or where such are not economically available, by stabilizing or treating the natural soil. The primary materials for economical use are granular materials with soil binder. In general, top soil binders are superior to clay binders because ages of exposure have weathered out soluble and unstable portions of the binder. The character of the granular material, sand, gravel, crushed stone or slag, that should be used depends upon local availability. Real economy in road construction can only be accomplished through the full utilization of local materials. The use of suitable local materials not only decreases the cost of construction but usually results in greater permanence, because such material has long withstood the weathering effects of the locality. There are glaring examples where the engineer has ignored the existence of excellent foundation and base course material

This Pavement Would Have Been as Good as That on the Adjoining Section if Proper Engineering Had Been Applied to the Foundations and Subgrade Conditions

in the roadway cuts and nearby deposits, material actually used and proven successful in earlier adjacent construction, and used other or imported material he thought superior with resultant failure of the wearing surface carried. The successful construction of a foundation must be based upon as complete information as can be obtained on the behavior of similar subgrade material and similar base course material under similar pavements or wearing courses. Recent laboratory research has made available much valuable information on the characteristics and effects of numerous materials. The Bureau of Public Roads and others interested have led the way to a better knowledge of soil mechanics and soil chemistry. Subgrade soil surveys are now becoming a part of the regular design procedure of many State highway departments, but the utilization and expanding of this knowledge has not yet received its proper attention by the profession at large.

The engineer of each locality must obtain solutions to his own particular road problems. In the past there have been too many cases where methods and materials successful in one section have been transported without change to other sections of the country having entirely different climatic and soil conditions with only partial success at the best and usually with costly failure. The road must be designed to fit its individual governing conditions, not to conform to arbitrary construction standards. Observation and study of results obtained in other sections are of immeasurable value in providing an approach to the solution, though they do not provide the solution itself.

Engineers have been too slow to profit by their own experience and the experience of others. Overemphasis of the theoretical design of the pavement itself, coupled with competitive pavement propaganda, have centered the attention of engineers on the design of pavement or wearing course alone, rather than on the whole structure from subgrade to riding surface. This has prevented widespread recognition of the real causes and logical analyses of the failures. As a result expensive mistakes have been repeated again and again and will be until the underlying causes of failure are promulgated without bias. Specifications have been rigidly adhered to long after it should have been apparent that they were defective.

There is a crying need for the economical development of secondary roads and much of this is now underway and more will be undertaken next year. The waste that has taken place in the development of the state systems should be prevented and the lessons learned at prohibitive cost utilized in this work. There are now sufficient existing roads in service in nearly every section to provide ample opportunity for the study and economical solutions of the problems in that section.

The type of wearing surface or pavement should be selected to fit the foundation and climatic conditions. A properly constructed low cost pavement on an adequate foundation may be developed by stages into the very high type. A thin, flexible wearing surface on a stable base course may easily be modified. The distortion that results from subsidence, settlements or distortion of the subgrade with time can be easily and economically corrected. However, even thick, rigid bases and pavements placed on non-uniform subgrade have cracked, distorted and even disintegrated to the extent that reconstruction will be necessary from the foundation coarse up.

The regular maintenance costs as kept often fail to present a true picture of actual conditions. To properly evaluate the maintenance data on the ordinary highway one must obtain the complete history of the road and then make a thorough investigation of the governing conditions.

In a few years the maintenance costs of pavements built on inadequate foundations often equal and sometimes exceed the original cost of construction. Overburdened maintenance budgets are usually saddled with the expense of reconstruction and the correction of failures.

In the past too much emphasis has been placed upon the strength and stability of the pavement itself and too little devoted to the changes that occur in the constituent materials themselves under adverse weathering. The life of Portland cement concrete in some localities has proven as uncertain as in sea water. Asphalt cements from some sources of supply, even though acceptable under standard tests, commence to deteriorate immediately on exposure under some climatic conditions. No reliable tests have yet been discovered for determining the necessary and desirable properties of bituminous residues. The chemical composition of oil asphaltic materials is varied and complex, resulting from the use of different crude materials and different methods of refining and many so-called high type asphalt pavements have oxidized, become brittle, and cracked badly before a decade of service.

It appears to the writer that the use of soluble chemicals to stabilize subgrade and base or foundation courses will be open to serious question until it is known that the admixture will not be dissipated and the stability of the subgrade or foundation course destroyed before the end of the economic life of the improvement; especially is this true in localities having heavy rainfall and complicated soil conditions. The writer has noted that the capillary action appears more intensive during spring months than in the fall and much more intensive than during midsummer, even though the moisture content of the soil is the same. It is possible that this activity is a phenomenon coupled with the rise of the sap in the trees and plants.

If our vast highway system is to be improved and kept to the condition demanded by the highway user, better roads must be built at lower costs than now prevail, and this will be possible only when local materials are utilized to the extent possible through the practical application of soil chemistry and soil mechanics.

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Dump Truck Operator Adopts Diesel

What is said to be the first large order placed by a dump truck operator in America for Diesel engines was recently executed by the B. Turecamo Contracting Co. of Brooklyn, N. Y., a contracting firm which does a great deal of work in road building, in the New York territory.

For years the Turecamo Contracting Co. have used Diesel engines almost exclusively in their fleet of towboats that are used to pull scows of gravel and crushed rock. In the Spring of 1936, they made the first installation of a Diesel engine in one of their A. C. Mack dump trucks. So successful was the operation of the Cummins HB-4 engine that in early October they placed an order with the Cummins Diesel Sales Corporation of New York, for 18 additional engines of the same type. This order completely Dieselized their fleet of Mack dump trucks. They use these trucks between their Marine Terminal at the foot of 24th Avenue, Brooklyn, and their various contracting operations.

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459 Cities Now Operating Under the Manager Plan.—Fifteen cities and one county adopted the council-manager plan in 1935. The largest city was Trenton, N. J., with a population of 123,356. The county was Monroe in New York State.

ROOSEVELT ON ENGINEERING EDUCATION

By HALBERT P. GILLETTE

NEWSPAPERS of October 22 carried a letter to 100 colleges from President Roosevelt declaring that engineers must help solve unemployment problems and implying that present engineering curricula must be broadened if this end is to be attained. He said:

"Events of recent years have brought into clearer perspective the social responsibility of engineering.

"In respect of the impact of science and engineering upon human life—social and economic dislocations as well as advance in productive power—the facts are revealed with distressing clearness in public records of unemployment, bankruptcies and relief.

"The design and construction of specific civil engineering works or of instruments for production represent only one part of the responsibility of engineering. It must also consider social processes and problems and modes of more perfect adjustment to environment, and must co-operate in designing accommodating mechanisms to absorb the shocks of the impact of science.

"This raises the question of whether the curricula of engineering schools are so balanced as to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility.

"I am calling this matter to the attention of educators of high administrative authority in the hope that it may be thoroughly explored in faculty discussions and in meetings of engineering, educational and other pertinent professional associations."

Although the questions thus raised by the president are not new, it is well that they should be discussed anew and more thoroughly. About a generation ago Woodrow Wilson published an article entitled, "What Is a College Education For?" His answer was, "to train for leadership." In an editorial article I agreed with him as to that object but I disagreed as to the sort of education best suited to the purpose. He advocated a classical curriculum with an A. B. degree as evidence of an adequately broad schooling. The reply was that no education can ever be broad as to a knowledge of facts or even of principles, for these are innumerable. The only educational "breadth" attainable is to be found in thorough training in scientific methods of fact gathering, fact analysis and fact application. This sort of training was then and still is given more thoroughly in engineering than in classical courses. As partial evidence of its effectiveness, attention was called to the rapidly increasing percentage of executives who had engineering degrees. Subsequent increases in that percentage confirm the opinion then expressed.

It has long been a pet hobby of classically educated men to regard their training as being "broad," in contrast with the allegedly "narrow" training of engineers. Seventy-five years ago this hypothesis was demolished by the greatest of English philosophers, Herbert Spencer, in his celebrated essay, "Education." It is not without its significance that Herbert Spencer was himself a civil engineer before he became "the philosopher of evolution."

I do not contend that engineering curricula are satisfactory. On the contrary, I believe that they are weak in three respects: (1) Training in engineering and business economics; (2) training in fact gathering, and (3) training in the interpretation of facts. These last two may be grouped under one head, namely, scientific research. As yet it is the common practice to make research a post-graduate training. This is, I believe, the most serious defect of engineering curricula, and it is equally a defect of all other undergraduate courses. Since very few men take post-graduate courses in scientific research, America would make a sorry showing both in the discovery and in the novel application of scientific principles were it not that many men, by the aid of books and magazines, train themselves as researchers. Inventors are here classed as researchers.

Unfortunately books on research methods are both few and inadequate. Among the best is one more than a century old, Herschel's "Discourse on the Study of Natural Philosophy." In how many engineering college libraries is that truly great work to be found? It may be well to ask also, how many libraries contain "Whewell's "Philosophy of Discovery" and his monumental "History of the Inductive Sciences," whose practical value exceeds that of any political history that I have read, to say nothing of its inspirational value, about which a great deal could be said.

Fact gathering is not made habitual in any undergraduate curriculum that I have heard of. Yet no habit is so essential to success in life as the fact-gathering habit. Most pedagogues are agreed that the main object of education is to "learn how to think." But of what use is an ability to think if a man lacks adequate data with which to think? It has been taken for granted that the necessity of adequate data is so obvious that no training in fact-gathering is needed. But let it be noted that while most college graduates appreciate the hygienic need of regular exercise, few take it, and those few are actually men who become habituated to it as college athletes.

The typical mathematical or physical or chemical or engineering text-book contains all the data needed in solving the problems that the book contains. But in solving the problems of business and engineering, most of the needed facts must be gathered by the problem-solver himself. The book holds all the needed facts in orderly array, neatly indexed. The big job is to find them. Few engineers are incapable of applying facts correctly when found. Therefore I disagree with the teacher who believes that his main task is to teach pupils how to think. His main task is to habituate them to gather all the facts needed in solving problems. His secondary task is to teach analytical and synthetical methods and principles applicable in solving problems. Finally comes the most difficult yet the most fruitful of all his

tasks, namely, the training of men to discover new principles and to apply known principles in novel and economic ways. It is a mistake to believe that research can not be taught. It is equally erroneous to believe that such teaching should be postponed until after graduation.

President Roosevelt apparently has in mind no such "broadening" of engineering curricula, but I suspect that he believes that the "broadening" should consist in adding courses in political economics and the like. I have read some 20 books on so-called "economics" that, speaking definitely, are not treatises on economics but on political economics. The meagerness of the data that they contain is alone sufficient to condemn them as suitable text-books for students seeking to learn how to solve economic problems. Contrast Taussig's three-volume economics that has been so long used at Harvard with, say, Ketchum's "Design of Highway Bridges," if you wish to appreciate the distinction between long-winded debates about questionable principles and concise, definite instruction on the use of well established quantitative laws. Taussig's treatise, which is typical, is political economics aborning. Its ambitions are vast. But it is as primitive as Aristotle's logic, which at best is only a glorified grammar and at worst a mere dictionary of terms.

No, the solution of problems in social economics is not to be learned from the typical text-books on political economics. Only an application of scientific research methods will solve such problems in fields political as they have been solved in fields physical.

Minnesota Highway Department Prepares for Winter

Approximately 450 snow plows are ready for the annual task of keeping Minnesota trunk highways open to winter traffic, according to N. W. Elsberg, State Highway Commissioner.

The plows are distributed among the 16 state highway maintenance districts. The equipment consists of 114 power graders used in slush and light snow; 95 one-way plows which throw snow to one side of the road only; 245 V-type plows which throw snow to both sides and can cope with heavy snows and drifts; 12 truck mounted rotary blower plows for extremely deep drifts.

The V-plows weigh more than a ton each, and are attached to 3 to 5-ton trucks. In severe storms two such trucks work coupled together in tandem while bucking drifts.

During the past year a number of 3-ton trucks which had worn out were replaced by 4 and 5-ton units to provide greater power for battling snow on the 11,340 miles of trunk highways.

As a preventive of blocked roads, the highway department has erected more than 1,000 miles of snow fence at locations where drifting occurs every winter. To combat the dangers of ice coated roads, the highway department has placed 10,000 cu. yds. of gravel and 100 tons of calcium chloride in stockpiles at strategic locations throughout the state.

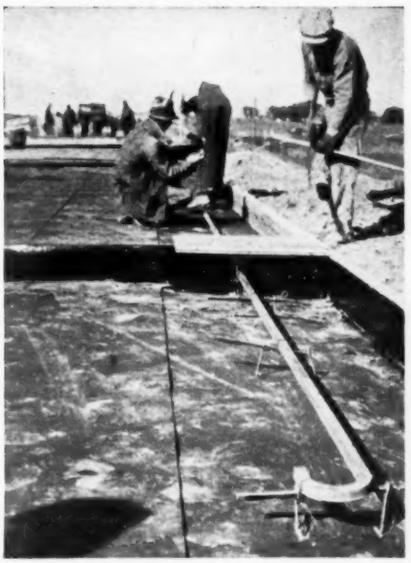
An Aerial View of the Western Gateway Bridge at Schenectady, N. Y., Recently Lighted with 67 Sodium, or "Golden Light," Luminaires

THE KANSAS EXPERIMENTAL CONCRETE PAVING PROJECT

Five-Mile Road Built to Test Laboratory Theories Under Actual Field Construction Conditions

By R. G. PORTER

Resident Engineer, State Highway Commission, Lawrence, Kan.



Installing the 1-In. Square Bars for Strain Gauge Measurements

THE Kansas State Highway Commission let a contract May 25, 1935, for the construction of an experimental paving project. This project is located in Douglas County, just east of Lawrence, Kansas, on highway No. 10. It is a PWS project and designated as 10-23-PWS-2.

The project is 5.005 miles in length and is divided into

Inspection Boxes. By Removing Lids Samples of Subgrade and Density Tests May Be Made

20 sections. The sections vary in length from 600 ft. to 3,400 ft., though the longer sections are divided into two or three parts. (See the key to construction.)

It was the object of this test road to test in actual field construction conditions some of the theories advocated from laboratory tests.

Observations on Kansas pavements indicate that subgrade conditions are, to a major extent, responsible for the rough riding surfaces. With this in view, a very extensive study is being made of subgrade conditions.

Subgrade Treatment

Several different methods of treating or manipulating the subgrade were tried out. A brief explanation of the different types of subgrade treatment is listed. When the treatment extended more than 6 in. in depth, it was worked in 6 in. lifts.

A_1. Manipulated and compacted with a moisture content of ± 5 per cent of the lower plastic limit.

A_2. Dried to 10 per cent moisture by dry weight, 6 in. depth, and compacted.

A_3. Ponded to ± 5 per cent lower plastic limit to a depth of 6 in. Not compacted.

A_4. Dried to 10 per cent moisture, 24 in. deep, covered with burlap and sprinkled continuous for 48 hours.

B_1. The top 6 in. to be removed, then 18 in. dried to 10 per cent moisture and compacted.

1. The top 6 ins. to be removed, then 18 in. dried to be ponded to 5 per cent above lower plastic limit, then covered with 6 in. selected low lineal shrinkage topsoil compacted.

B_3. Dried to 10 per cent moisture, 24 in. depth, then treated with cutback asphalt.

B_4. Powdered admixture consisting of 45 in. cement per square yard to be mixed with earth to a depth of 12 in. Then to be wet down, manipulated and rolled.

D_1. Ponded to 5 to 15 per cent above lower plastic limit without compaction.

D_2. One-half sand cushion on natural subgrade.

Expansion Joints

It is believed that one of the principal causes for warp-

Thermometer Setup for Recording Temperature of Top, Middle and Bottom of Slab and Subgrade 6 In. Below Slab

KEY TO CONSTRUCTION

Sec. No.	Sta. to Sta.	Subgrade Treatment: Type	Subgrade Treatment: Description of Subgrade	Subgrade Treatment: Shoulders	7"-9"-7" Pavement 20': Type	7"-9"-7" Pavement 20': Expansion Joints	7"-9"-7" Pavement 20': Contraction Joints	7"-9"-7" Pavement 20': Reinf.	7"-9"-7" Pavement 20': Subgr. Paper	Concrete: Cement Sack/Yd.	Concrete: Water: Cal.	Concrete: Water: Slum.	Concrete: Aggregate: Co.	Concrete: Aggregate: Fin.	Concrete: Aggregate: Mix.	Finish	Curing
1	a. 9+33-19+61.2 b. 19+61.2-26+62.5	D_3	Natural conditions Standard construction	S_1 No treatment St'd const.	....	a. None b. Water Tight Load Trans.	a. None b. Water Tight	a. Nominal b. Fabric	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
2	a. 26+62.5-38+70.5 b. 38+70.5-50+78.5 c. 50+78.5-62+86.5	A_1	Manipulated and Compacted a. depth 6 inches b. depth 12 inches c. depth 24 inches	S_2 Bituminous Treatment	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	....	....	Yes	Standard	72-hour Burlap
3	a. 62+86.5-68+90.5 b. 68+90.5-74+94.5	A_2	Ponded	S_2	....	100'-8" ctrs. a. Water Tight b. Modified Open bars. Alt. Jts.	a. Water Tight b. Open	Nominal	Yes	.....	5.75	2" Mim.	....	....	....	Standard	72-hour Burlap
4	a. 74+94.5-87+02.5 b. 87+02.5-99+10.5 c. 99+10.5-111+18.5	A_3	Dried and Compacted a. depth 6 inches b. depth 12 inches c. depth 24 inches	S_2	....	100'-8" ctrs. a. Water Tight b. Modified Open c. Drains	a. Water Tight b. Open-Alt.-bars c. Open-Alt.-bars	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
5	111+18.5-121+25.12	B_1	Dried and Treated 6" selected top soil (Prepared same as A_3)	S_2	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
6	121+25.12-127+29.1	A_4	Dried and Sprinkled (Prepared same as A_3)	S_2	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
7	127+29.1-161+40.5	D_2	Sand Gravel Treatm't (Prepared same as D_3)	..	....	100'-4" ctrs. Water Tight Load Trans.	None	56 lb. Fabric	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	Earth
8	161+40.5-167+44.5	B_2	Ponded and Treated 6" select top soil (Prepared same as A_3)	S_4 Oil penetration	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
9	167+44.5-173+48.5	B_3	Dried and Bituminous Treatment (Prepared same as A_3)	..	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
10	173+48.5-179+52.5	B_4	Powdered Admixture	..	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	72-hour Burlap
11	179+52.5-191+56.5	D_1	Excessively Ponded	S_3 Low lineal shrinkage	....	100'-4" ctrs. Water Tight Load Trans.	None	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Delayed Vibrator	Earth
12	191+56.5-203+64.75		D_1	S_3	....	100'-4" ctrs. Water Tight Load Trans.	Water Tight	56 lb. Fabric	Yes	.....	5.75	1" Mim.	....	....	Yes	Delayed Vibrator	Earth
13	203+64.75-215+72.7		D_1	S_3	....	100'-4" ctrs. Water Tight Load Trans.	Water Tight	56 lb. Fabric	Yes	.....	5.75	1" Mim.	....	....	Yes	Standard	Earth
14	215+72.7-227+76.7		D_1	S_3	....	100'-4" ctrs. Water Tight Load Trans.	None	Nominal	Yes	.....	5.75	2" Mim.	Yes	Yes	....	Standard	Earth
15	227+76.7-239+84.7	D_3	Natural Conditions (Standard const.)	S_3	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	No	.....	Johnson Method	....	Yes	Yes	....	Johnson Method	Earth
16	239+84.7-245+88.7		D_3	S_3	....	100'-8" ctrs. Modified Open Bars. Alt. Jts.	Open	Nominal	No	.....	Johnson Method	....	....	....	....	Johnson Method	Earth
17	245+88.7-251+90.7 251+90.7-257+92.7		D_3	S_3	....	100'-4" ctrs. a. Water Tight Load Trans. b. Poured-premld.	None	56 lb. Fabric	Yes	.....	5.75	Very Dry	Yes	Yes	Yes	Standard Vibrator	Earth
18	257+92.7-263+94.7		D_3	S_3	....	100'-4" ctrs. Poured or Premolded bars @ 13"	None	56 lb. Fabric	Yes	.....	5.00	2" Mim.	Yes	Yes	Yes	Standard	Earth
19	26.3+94.7-269+96.7		D_3	S_3	....	100'-4" ctrs. Water Tight Load Trans.	None	56 lb. Fabric	Yes	.....	6.25	2" Mim.	Yes	Yes	Yes	Standard	Earth
20	269+96.7-275+98.7		D_3	S_3	....	100'-4" ctrs. Water Tight Load Trans.	None	56 lb. Fabric	Yes	.....	7.00	2" Mim.	Yes	Yes	Yes	Delayed Vibrator	Earth

ing at the joints is due to moisture change in the subgrade. Different types of expansion joints are being tried out on this project. One joint in particular is a special joint, designed to allow water through the joint to the subgrade yet prevent debris from filling the joint. Moisture and density tests were made immediately ahead of the paving. Inspection boxes were placed in the pavement at various types of joints in order that moisture and density samples could be taken at a later date.

How Measurements Are to Be Made

Pressure cells are being used on this project to measure the pressure of the subgrade on the pavement, due to changes in the moisture content of the subgrade. To determine whether it is soil pressure or working of the slab due to temperature differential in the slab, a set of dials held by a ridged frame can be installed on the surface of the pavement above the pressure cells. The pressure cells may be used for studying load distribution. Forty-four of these cells were installed.

Concrete posts, imbedded in a foundation of concrete

Top of Post, Showing Brass Bars in Pavement and the Brass Bar from Post. Vertical Movement Is Measured Between Bars. The Horizontal Movement Is Measured Between Bars in Pavement and the Bar Fastened to the Plate or Post

below the frost line and protected from earth movement and frost action by metal tubing, have been installed to provide a method for accurately measuring the horizontal and vertical movement of the slab. Measuring devices are fastened to these posts and the slab. There were 126 of these posts installed.

Subgrade friction is being measured by the strain

Jacks in Place and Dials at Positions 1 and 2 for Second Test on April 29. Note Position 9, Dial Set Across Joint, Catching Movement on Both Slabs

Positions (3, 5, 7) at Which Readings Were Made on April 10 After Bars Were Cut and Slab Moved with Jacks

set-up in two 1 in. bars which tie two 50 ft. sections of slab together. At some later date the bars will be cut and check tests made by jacking the slab, measuring the movement of the slab. Also the movement of the subgrade. Three such installations were made.

Precise levels are taken on ¼ in. brass plugs countersunk below the surface of the pavement. Ten such plugs are placed at each expansion joint and six at each contraction or construction joint. In addition to these, a profile is taken on each side and on center line at 10 ft. spacings.

The first set of precise levels was taken as soon as possible after the pavement was placed. The second, third, etc., will be taken depending on seasonal or unusual weather conditions.

Recording thermometers are recording the temperature of top, middle, bottom of slab and the subgrade 6 in. below the slab. Three standard rain gauges, a self-recording thermometer, barometer and humidigraph are used to record the weather.

Two types of aggregates were used for the concrete. Coarse and fine aggregate and total aggregate. Coarse and fine aggregate concrete was placed with the following W/C: 5.00 Gal., 5.75 Gal., 6.25 Gal., and 7.00 Gal., 5.75 being the standard.

Cores were removed from the slab for strength and freezing and thaw tests. Crack surveys are made at intervals and all unusual conditions noted and recorded.

Only the major points have been mentioned. No conclusions have been reached. The data and recordings are being collected and will be assembled as time permits.

By having a thorough knowledge of conditions before paving and studying the results, it is expected that we may gain information for the design and construction of concrete pavement.

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Roadside Improvement for 5,000 Miles of Highway

Improvement of roadsides by landscape grading, seeding, sodding, and planting has become increasingly popular in recent years. Since 1933 it has been required that each state include roadside improvement projects in its program of work to be done with Federal funds administered by the Bureau of Public Roads. The total program—completed, under improvement, and planned—includes 1,391 sections of road improved according to plans prepared by landscape specialists. Roadsides have been, or are being, improved on approximately 5,000 miles of highway at a cost of more than $7,000,000, of which the Federal government is contributing more than $6,000,000.

Grouting Under a Pavement Patch at Elizabeth, N. J. Grouting Machine in Foreground

PREVENTING SETTLEMENT OF PAVEMENT PATCHES

By ROBERT S. MAYO

Construction Engineer, Ransome Concrete Machinery Co. Dunellen, N. J.

ONE of the latest uses for compressed air is the grouting under patches in pavement cuts to compact the backfill and thus prevent settlement of the patch. The repairing of street surfaces torn up by the work incident to laying or repairing underground services has always been a problem to public utilities, water companies and sewerage and water departments. In recent years this problem has become more serious. The street departments dislike to see their expensive pavements cut and repatched because the eventual settlement brings a deluge of complaints from the motoring public regarding the roughness of the street. Some cities, when they lay expensive pavements, refuse to give permission to the utilities to break this surface for a period of years, because of unsatisfactory patches.

Proper Packing of Truck Fill Difficult

This condition was caused by the impossibility of ever packing the filling in the trench to its original density. Even with the development of pneumatic tampers to ram the layers of earth as the trench was backfilled, settlement still took place, varying in amount with the type of earth and the care taken in tamping. This settlement removed the support from under the concrete patch which then gradually sunk under the pounding of heavy traffic. When the patch had sunk too far, it was necessary to tear it out, ram in another layer of earth, and then put in a new patch. In some cities, the street departments insist on doing all the patching and then back-charging the utility for it. This was of course expensive and did not relieve the utility of the risk of ill-will of the motoring public or the possibility of damage suits. One utility was forced to pay a great number of small claims: water collecting in these depressions was splashed onto the clothes of pedestrians, who promptly entered claim for new clothing.

This problem has been intensified in the last few years for the gas companies. Due to the immense increase in recent years of automatic gas regulating mechanism in refrigerators and water heaters, it has been necessary to furnish a "dryer" gas to the customer. Removing of the tars and oils from the gas has caused the yarn caulking of the joints to shrink and leak. To stop the leaks in existing lines it has been necessary to fit an iron collar with an external gasket about each joint. Thus the gas companies have been forced to recaulk mile after mile of gas line, by digging pits, 4 ft. by 4 ft. over each joint, 12 ft. apart. There would be 440 patches required for each mile of main reinforced.

Grouting Procedure

Mr. Frank A. Engel and Mr. Dennis J. Manning, Superintendent and Assistant Superintendent of Distribution for the Elizabethtown Consolidated Gas Co., of Elizabeth, N. J., were faced with this problem. They decided to solve it by the method which had been used for years to consolidate ground and to fill fissures under big dams. A Ransome pneumatic grout mixer and placer was purchased and the cavity under several patches grouted. This proved so simple and effectual in stopping settlement of the patch, that after a little more experimentation he evolved the following procedure, which is now standard with his company.

The grouting equipment consists of a light truck on which is mounted a 110 cu. ft. gasoline driven compressor which furnishes air for a jack-hammer drill and the grout machine. The grouter is carried in a 2-wheel frame which is trailed behind this truck. Another truck accompanies, carrying sand and cement. Ninety days after the street has been patched, or 120 days if the weather has been very dry, the grouting crew passes over a series of patches. A hole, 1⅞ in. in diameter, is drilled in the center of each patch, these patches being in most cases 4 ft. by 4 ft. The foreman then drops an electric light, whose power is furnished from a storage battery, into each hole and inspects it to see if grouting is required. If the apparent settlement is ½ in. or less, no grouting is specified. Generally about one-third of the patches will require no grout.

The Ransome grouter is a cylindrical tank with conical bottom leading to a nozzle. It is mounted in the trailer frame in such a manner that the nozzle can be lowered into a hole. There is a swivel plate and rubber gasket around the nozzle; thus the weight of the machine is used to keep the gasket tight against the surface of the street. The grouter has a 3 cu. ft. tank but is generally used with 2 cu. ft. batches. Water is put in the machine and cement and sand slowly added. Mixing is done rapidly and thoroughly by the "agitation" principle. The charging door is then closed and

East River Boulevard, Minneapolis, Minnesota. Tarvia since 1910. One of the scores of Tarvia roads that have served Minneapolis continuously for twenty years or more.

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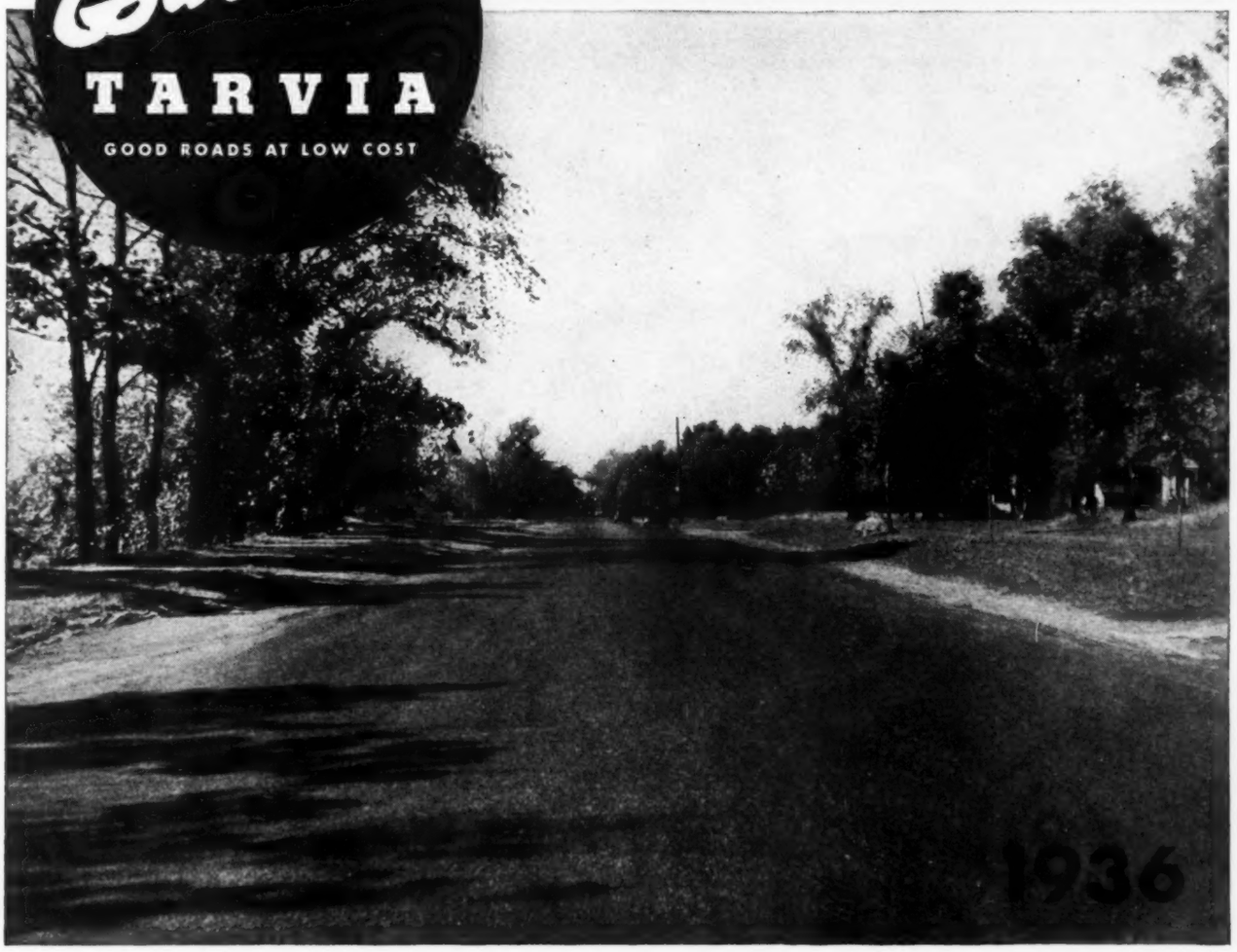

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air pressure applied to force the grout through the nozzle. When the cavity is filled, two men roll the grouter to the next hole and prepare another batch. Two cubic foot batches have been found about correct for most patches.

The grout is a rather "soupy" mix of 1 part of cement to 6 parts of sand. Fifteen pounds pressure is generally used for forcing in the grout. Mr. Manning has installed a pressure regulating valve between the compressor and the grouter which can be adjusted to any desired pressure. This precludes a careless operator using too much pressure. Too much pressure on the grout might raise the patch, or would waste grout by forcing it under the adjacent slab or down some channel to the sewer.

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Example of Economy and Efficiency of Method

An unusual example of the efficiency and economy of this system occurred on one of the principal streets of Elizabeth recently. Fifteen years ago, a 20-in. main had been recaulked; there were thirty patches originally, each 5 ft. by 5 ft. One patch settled and had to be removed; because of the large cavity and area, 7 ft. by 7 ft. was replaced. An inspection of the remaining patches showed that the backfill had settled away from the slab an average of 4 in. It was estimated that to barricade the street, break out and remove the old patches, add more backfill, and then replace the patch, it would cost about $35.00 each or approximately $1000 for the job. Three men grouted the remaining 29 patches in a half day's time, and without seriously interfering with traffic.

Where large-size mains pass under wide and expensive pavements, it is often much cheaper to tunnel than it is to cut the pavement. However, most street and highway departments forbid this because it was impossible to properly ram the backfill so that eventually the edges of the tunnel would not settle, permitting the unsupported pavement to crack and break. Mr. Manning has satisfactorily solved this by drilling holes, 8 ft. apart over the center line of the tunnel. Through these holes, grout is introduced to compact the backfill and reinforce the pavement.

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Maryland Raises Labor Incomes

Wage and salary adjustments for employees of the Maryland State Roads Commission became effective October 1, 1936. Six hundred forty-two (642) employees will receive pay increases. Forty-five (45) will be decreased. The State Roads Commission employees work under a merit system. They are rated by their immediate supervisors as well as officers of the commission. All cards are reviewed by the chairman. This is a particularly good move at this time when the state is launching into a larger construction and betterment program. The salary changes are put into effect in accordance with a standardization adopted last spring by the commission. It affects those paid on an hourly basis as well as those receiving yearly salaries. As a result the payroll will be increased by $28,092.

This extra cost will be easily offset by extra efficiencies obtained in the use of heavier maintenance and construction equipment. The average raise amounts to $120 per year, varying from $60 to $720. The larger raise affects the inspector on state and county road maintenance work.

COUNTY HIGHWAY ADMINISTRATION IN KANSAS

By J. W. MAVITY
Harvey County Engineer, Newton, Kan.

COMPULSORY engineering service for counties in the state of Kansas dates back to 1917, when the legislature passed a law making it compulsory for the counties of the state to appoint a competent road builder or supervisor of roads, whose official title should be county engineer. This was done in all counties except those where there was not a sufficient amount of road or bridge work to keep the county engineer employed throughout the year. The law in this case provided that the board of county commissioners of any such county, with the approval of the state highway commission, could unite with the board of county commissioners of an adjoining county or counties and form a county engineer district and employ a county engineer for the two or more counties included in such district.

This law also provided that not more than six counties be included in any one district, and that it should not include more than $100,000,000 assessed valution. This law provides the duties of the county engineer, which are as follows:

The Duties of the County Engineer

"That it shall be the duty of the county engineer, in conformity with the regulations and requirements of the state highway commission: (1) To prepare plans and specifications and estimates for roads, bridges and culverts built by the county. (2) To act for the county in all matters relating to the supervision of the construction, repairing, surfacing, resurfacing and maintenance of any roads, bridges, or culverts, or anything pertaining to rivers, streams or water courses, for which the county pays any part of the cost thereof. (3) To visit and inspect the highways and bridges in each township of his county or district at least once in each year, and advise and direct the township board of highway commissioners and the road overseer of each township as to the best methods of construction, repair, maintenance and improvement of such highways, bridges and culverts. (4) To prepare plans, specifications and general regulations governing the construction and maintenance of township roads, bridges and culverts, and to furnish copies of the same to the township board of highway commissioners and to the road overseer of the several townships of his county or district. (5) To keep a record of all contracts and of all purchases of material, machinery or apparatus to be used in road construction in excess of $200, approved by him in any township as herein provided. (6) To study the soil conditions and collect information concerning the various deposits of gravel, stone, sand, clay and other road and bridge building materials, and to investigate and determine the most approved methods of using the same. (7) To make maps of the roads in the different townships of his county or district, and where there are no other records, or the records are incomplete, he shall make maps and plats and file them in the offices of the County Clerk and Township Clerk, which when passed upon and adopted by the Board of County Commissioners shall be the records of such roads where there are no other records, and shall be additional and supplemental records when the former records are incomplete or imperfect. (8) To answer inquiries and to hold two or more public meetings annually to advise with highway officials in road, bridge and culvert improvement, and to perform all other duties required by law."

Designating County and Township Roads

After this act went into effect, it was the duty of the county engineer and the county commissioners to classify and designate the roads of their respective counties, according to the relative importance, as county roads and township roads. The county roads were to be the main traveled highways and should connect, as nearly as possible, the cities and principal market centers of each county with each other, as well as to connect the county roads in adjoining counties.

In counties having a total of 1,000 miles of public highways or less, the board of county commissioners and county engineer were to designate not less than 50 miles, nor more than 150 miles, as county roads and, in counties having more than 1,000 miles of public highways, not less than 10 per cent nor more than 15 per cent were designated as county roads, with the provision that counties that have an assessed valuation of more than $50,000,000, not less than 100 miles nor more than 25 per cent of the total public highway mileage should be designated as county roads and all other public highways were township roads.

Whenever any main traveled highway was located partly within and partly without a city and connected a county road with the city, by and with the consent of the governing body of the city, the board of county commissioners was given power and authority to designate such public highway as part of the county road system, and when so designated it was to be improved and maintained as other parts of the county system. It also gave the city authority to aid in the construction, maintenance and repair of said highway the same as though it were in the corporate limits of the city.

At a later date, the legislature designated 8,690 miles as state highways, the total mileage of which in each county was to be not less than the sum of the north to south and east to west diameters of the county, and which should connect county seats, principal cities, and market centers, and which highways and all bridges and culverts thereon should comprise the state highway system. All other roads were to be county and township roads.

Method of Handling Federal Aid

When the state system of highways was first adopted, there was a provision in the state constitution which provided that "The state shall never be a party to carrying on any work of internal improvement." Because of this provision in the state constitution, Federal Aid was set up in Kansas on the basis of the counties doing the work under the supervision of the state highway com-

mission. During this time, very competent engineering departments were built up, some of the counties having some of their organization to the present day. This method of handling Federal Aid was continued for a number of years.

The Federal Government, after several years of handling it in this way, told the states that they would be given a certain time in which to change their constitution so that it could engage in road building. The county engineers of the state got behind the proposition and lent their wholehearted support in favor of this amendment. The amendment was voted on in the November election of 1928 and carried and went into effect with the spring of 1929. Thus the laws of Kansas were made to conform to federal requirements, and since then the state has engaged in both construction and maintenance and has built up a splendid highway organization.

When the state highway commission was first organized, it consisted of the governor and two men appointed by him. It now consists of five highway commissioners appointed by the governor, the commission appointing a director of highways, who serves at the pleasure of the board. The director, in turn, employs the engineers and other help of the state highway commission.

Road Work Under Benefit District

When the state was working through the counties, a large per cent of the improvement of roads was done under the benefit district law, which provided that when a petition, signed by 51 per cent of the resident land owners, owning at least 35 per cent of the land within the district, or signed by 35 per cent of the resident land owners owning 51 per cent of the land in the district, or signed by the owners of 60 per cent of the land lying within the benefit district, praying for the permanent improvement of the road in the benefit district, be filed with the board of county commissioners of any county where such road is located; then, if the board of county commissioners found such a road to be a public utility, it was ordered built and the cost assessed against the improvement.

Any Federal Aid or state aid applied to the road was deducted from the cost of the road, the remainder of the cost being apportioned 60 per cent to the county, 12½ per cent to taxable property of the township and 12½ per cent to the township in which the road is located apportioned according to the length of the road in the township, and 15 per cent among the several tracts of land within the benefit district.

County Road Unit System

The county load unit law is optional with the counties of Kansas. The board of county commissioners may adopt the provisions of the county road unit system by resolutions at a regular meeting of the board, or in the event of the filing with the county clerk of a petition signed by 20 per cent of the qualified electors in the county, the board of county commissioners shall adopt the provisions of the county road unit system by resolution in the next regular meeting of the board. The resolution must be published in a newspaper of general circulation in the county for at least three consecutive weeks. Such adoption shall take effect 90 days after date of the first publication of the resolution providing for such adoption, unless within such time there is filed with the county clerk a petition signed by 20 per cent of the qualified electors of the county, protesting such adoption, in which event the board of county commissioners is required to submit the question of the county unit system to electors of the respective counties.

About 20 per cent of the counties have adopted the county road unit system in Kansas. This law throws the burden on the board of county commissioners by requiring them to take the initiative in the matter. It is hardly fair to require the county commissioners to have to take the initiative in this matter. The county road unit law should be made mandatory. The counties that have adopted the county road unit system are more than pleased with the results obtained, and would not think of returning to the old township system.

Effect on Taxes of Taking Over Township Roads

The road unit counties have much better grades than under the old township system, and have five or more times as many roads under full time maintenance—and better maintenance—than did the townships. The remarkable part of it is that more work and better work is being done for less cost. Herewith summary of the decreased cost of operating under the county unit of nineteen counties that had adopted the county unit prior to 1932. No comparison has been made during the depression.

TABLE SHOWING THE EFFECT ON HIGHWAY TAXES IN THE 19 COUNTIES TAKING OVER ALL THE TOWNSHIP ROADS AND BRIDGES SINCE 1928.

	Annual decrease in taxes under county road unit system	Annual increase in taxes under county road unit system
1. Anderson	$ 7,724.00	.....
2. Bourbon	72,358.37	.....
3. Chase	.....	$1,281.68
4. Chautauqua	20,428.24	.....
5. Cherokee	2,731.60	.....
6. Clark	9,602.26	.....
7. Grant	.....	1,300.78
8. Gray	.....	1,083.46
9. Hamilton	.....	8,463.84
10. Haskell	7,277.43	.....
11. Hodgeman	12,566.28	.....
12. Jefferson	47,348.38	.....
13. Kiowa	13,445.90	.....
14. Labette	.....	15,809.40
15. Lincoln	14,910.73	.....
16. Miami	31,425.65	.....
17. Seward	9,438.18	.....
18. Stanton	.....	516.60
19. Wichita	3,751.04	.....
Totals	$253,008.06	$28,455.76

Total net saving, $224,552.30 in the 19 counties.

If all the counties in Kansas were under the County Road Unit System and saved in proportion of population to these 19 counties, it would mean an annual saving of $2,320,000 to the taxpayers of the state. This is but a small item nowadays when we talk of billions of dollars, but when we consider the better grades and better maintenance done by the county unit, it means several times $2,320,000 in value to the taxpayers of the state.

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Highway Safety Broadcasts

More than 250 radio stations have scheduled a series of three broadcasts devoted to "building safety into the American highway system" in a nationally-organized campaign to expand the highway safety co-operation that the American Road Builders' Association has extended during recent years to newspapers and other publications.

Sixty of the stations started the highway safety broadcasts last month. All of the 250 stations presented the first of the broadcasts by Nov. 10, and the program calls for completion of the series before the opening of the Convention and Exhibit of the American Road Builders' Association in New Orleans on Jan. 11.

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Moving gravel quick—LeTourneau Bulldozer bringing gravel into the crusher on a job near Neppel, Washington.

LETOURNEAU

Ohio Route 314 *in Morrow County, Stabilized During Summer of* 1934. *This Picture Was Taken in March,* 1936.

STABILIZED ROAD SURFACING IN OHIO

By S. O. LINZELL

Assistant Chief Engineer, Bureau of Maintenance
Ohio Department of Highways

ONE of Ohio's most interesting experiences with stabilization was in the construction, last year, of a 4-mile section of State Route 35 between Chillicothe and Washington Court House. T. E. Morgan, Assistant Division Engineer in the Ohio Department of Highways, described this project most comprehensively in an address before the Association of Asphalt Paving Technologists at Cleveland, on Jan. 23rd, and we cannot do better than extract portions of Mr. Morgan's address:

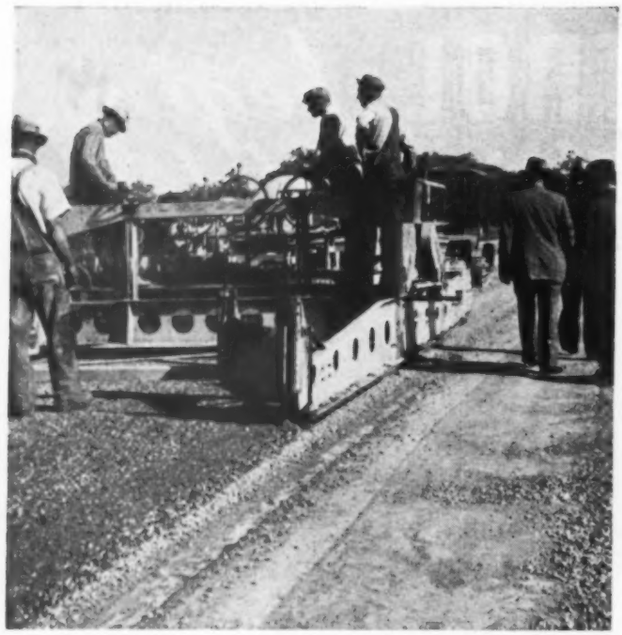
Converting a Bad Road Into a Good One in 10 Days

"Last Fall, during the latter part of September, a contractor working in our division completed four miles of new grade on a fairly heavily traveled U. S. route. This 4-mile section had been built on virgin ground, with a radical realignment to eliminate several dangerous railroad crossings. The plans provided for a traffic bound surface in accordance with our general specifications for this type of surfacing. The contractor had placed in windrows along the shoulder, with a thin covering over the subgrade, sufficient aggregate to provide for a 6-in. compacted depth, when, as, and if it became imbedded in the new grade. The section was duly opened to traffic with its dust and necessity for constant blading. In all probability it would have remained in this condition over the Winter except for certain conditions that developed. A rainy period softened the subgrade; deep ruts developed; the maintenance forces were kept busy trying to keep the grade in some state of stability, and traffic avoided the section, going around the old way over the railroad crossings. It was rather humiliating to have traffic reject the new improvement, and since we had just completed our experimental project with apparently good results, we were ordered by our chief engineer of maintenance to stabilize this section.

"We started immediately, and ten days later the 4-mile section was completed and opened to traffic with a 6-in. compacted 'clay concrete' slab of coarse and fine aggregate and clay cement, with calcium chloride as the chemical aid to stability. The section is still open to traffic in excellent condition and carrying an average of 1500 cars daily, of which a considerable percentage consists of heavy coal trucks on long hauls.

"In spite of any arguments against stabilization, one must be forced to admit there must be something to a theory that will provide for converting a road, thoroughly objectionable to traffic, into one entirely satisfactory to traffic, from the standpoint of support value, in the short period of ten days. Moreover, more aggregate was incorporated in that section in proper proportions in the 10-day period than could be incorporated in improper proportions in ten years by the traffic bound method, to say nothing of the wasting away of aggregate and the additional aggregate required from year to year, with its incidental maintenance costs.

". . . On this 4-mile section, the coarse aggregate was our No. 46 limestone, which all passes the ¾-in.



Jaeger Road-Builder Mixing 3-in. Course of Stabilized Material. Ohio Route 35, Between Chillicothe and Washington Court House

square screen. The sand for fine aggregate met our specifications for concrete sand as produced from limestone. The clay had a plasticity index of 14. The proportions were: 55 per cent coarse aggregate, 20 per cent sand and 25 per cent subgrade clay. The subgrade contained about 11 per cent sand, so the actual clay percentage was about 14 per cent. The pavement was built in two 3-in. courses, each thoroughly compacted. One pound of calcium chloride per square yard was integrally mixed with the top courses only, and 1 lb. was applied as a surface application. The equipment for mixing and spreading used on the work was the Jaeger triple pug mill road builder. This unit mixes and spreads to finished cross section for a 10 ft. width in one operation. Rigid control of proportions was attempted throughout the work, which, with the effective-

Stabilized Material Thoroughly Mixed and Ready for Rolling. Ohio Route 35

ness of the mixing unit, unquestionably was the major factor in securing the resulting dense concrete."

An Easily Constructed and Inexpensive Stabilized Road

The most easily constructed and inexpensive stabilized road built by the Ohio State Highway Department is located on State Route 314, in Morrow County north of the village of Chesterville. Before stabilization, this road had been maintained as an ordinary traffic-bound type, with considerable breaking up during the Spring thaws and a dusty condition hard to control in Summer.

Surface Application of Calcium Chloride, the Last Step in Construction of Stabilized Wearing Course on Ohio Route 35

When it had been decided to stabilize this road, it was found that a local gravel pit, only ½ mile from one end of the job, contained coarse and fine aggregate of almost perfect gradation and an abundance of clay soil overburden. Analysis revealed that, by leaving about 18 in. of this overburden on the pit, and shoveling it out with the gravel, an amount of clay was obtained sufficient to provide binder for the aggregate. The mixture contained proper amounts of gravel and sand, with approximately 14 per cent silt and clay binder-soil. A power shovel was used to partially mix the clay with the aggregate in the pit before loading the trucks.

Power graders were used to spread the material on the road and, after the oversized material had been removed with a mechanical rake, thorough mixing to a uniform composition was accomplished by means of the power graders. The finished mixture was then spread out carefully in three longitudinal strips with a power grader. First, a strip about 8 ft. wide was spread down the center of the road, leveled and rolled, after which a strip approximately 6 ft. wide was spread on each side. The center strip served as a guide for the two side strips. After careful rolling, a uniform application of ½ lb. of flake calcium chloride per square yard was made.

Since there were periods during construction when rains were infrequent, it was necessary at times to add

Stabilized Ohio Route 35 During the Severe Winter of 1935-36

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PURE IRON - COPPER ALLOY
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Meets copper-bearing pure iron requirements in all accepted specifications for corrugated metal culverts.

WHEREVER GOHI Corrugated Pipe is installed, it is an unmistakable sign of progress. Because GOHI Pure Iron-Copper Alloy has proved to be the longest-lived, low-cost ferrous metal for drainage structures, it insures maximum protection against the destructive action of wear, weather, corrosion, abuse and neglect for the greatest number of years.

Your own highway investment will pay higher dividends in uninterrupted service, freedom from road tie-ups, and costly repairs when you install GOHI Corrugated Pipe Culverts. Get all the facts from the fabricator nearest you.

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Dixie Culvert Mfg. Co.	Little Rock, Ark.
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(61)

GOHI

PRONOUNCED "GO-HIGH" CORRUGATED PIPE

GOHI CULVERT MANUFACTURERS, INC., . . . NEWPORT, KY.

Stabilized Ohio Route 35 As It Looked in May, 1936, After the Winter and Spring Break-Up

moisture to the mixture before rolling. It is essential that the aggregate-clay mixture be moist when rolled, in order that the mass may become sufficiently dense and compact to produce a satisfactory surface.

The aggregate-clay mixture was placed on the road in two layers, the first being 2 in. thick and the second 1 in. thick. The first layer was completely finished, as described, before the second layer was placed. Practically the same methods were used to lay the second course, and it was finally treated with ½ lb. of calcium chloride per square yard.

Because of the proximity of the materials used and the extremely low cost of the aggregate (10 cents per cubic yard), the direct costs for labor, material and machinery fuel were approximately $680 per mile. It should be remembered, though, that this figure does not include equipment rental, depreciation and overhead, which would probably increase the total cost figures by 30 to 50 per cent.

This writer in a previous article has stated:

"Frequently after a traffic-bound road has been maintained and material added year after year, it is decided to improve it or 'step up the type' by overlaying it with some type of bituminous surface. All too often it has been the experience of engineers to find that the supposedly stable traffic-bound base was very weak and has caused the extensive failure of the bituminous surface. Investigation in these cases often showed that the traffic-bound course varied from 1 to 4 in. in thickness and that these weak places were not noticed prior to the placing of the bituminous surface, owing to the fact that continual drag maintenance had hidden these weak spots. The uniformity of thickness and composition of the stabilized surface should make it an ideal base for a future bituminous surface should the traffic demands be such that a higher type of surface is desirable."

Ohio Route 359 in Virginia-Kendall Park, April, 1934, Before Stabilization.

The stabilization of a 1¼ mile section on State Route 359 furnished the Ohio Highway Department another interesting experience with this method of low-cost road improvement. Route 359 is the principal road into Virginia Kendall State Park in Summit County.

Slag Used in Stabilization

In the Summer of 1933, this road was graded and about 3 in. of gravel added to the existing materials. When the following Winter and Spring played havoc with the surface, it was decided to stabilize the section. After the existing road material and the subgrade material had been thoroughly sampled, and tests revealed that the subgrade clay was of suitable character to use in constructing the stabilized road, the following procedure was followed.

The existing road surface was scarified to a depth of 1 in., leaving a small amount of gravel undisturbed, to serve as a base. Approximately 200 tons of clay per mile was bladed from the shoulders and taken from the back slopes, placed in windrows and allowed to dry. The clay from the back slopes was removed not only to obtain the desired quantity of binder-soil, but also to improve the contour of the road.

Five hundred tons of slag per mile was then windrowed with the scarified road material, together with

Ohio Route 359 in Virginia-Kendall Park, April, 1935, After Stabilization the Preceding Summer

190 tons per mile of suitable sand. The slag used was Ohio No. 46, consisting of ¾-in. material as top size, with the greater percentage ranging from ⅜ in. to ½ in. in size. The scarified material, the slag, sand, and pulverized clay were then thoroughly mixed together, moistened, and shaped to a crown of ½ in. per foot. Compaction was accomplished by means of a 5-ton flat roller and dual-tired trucks. The application of calcium chloride, at the rate of 1½ lb. per square yard, was spread entirely on the surface.

This stabilized road has received considerable traffic, much of it being of severe nature. The Civilian Conservation Corps has built shelter houses and parking lots, besides doing a lot of beautification work in the park, and much material has been hauled over this road in trucks. Although the trucks have been driven at a fairly high speed, the road does not show any detrimental effects. The many visitors to the park have brought the traffic count to from 600 to 800 vehicles per day. Although the road is surrounded by swampy land in several sections, it has held up during all seasons of the year and maintenance costs have been exceptionally low. Before stabilization, the road was impassable at times during the Winter and Spring.

WHY SPLIT UP YOUR PURCHASES OF ROAD STEEL ?

With time and money to burn you could probably do a pretty fair job of building a finisher with parts you bought here and there. However, that is much too inconvenient and impractical for you even to consider it.

What you do, of course, is buy finishers and similar equipment as single units. That's plain common sense—just as it is to buy all the road steel you need from a single source of supply. The policy of buying reinforcing bars here, paving plates there and other road steel somewhere else again usually means delays, considerable inconvenience and it can mean a definite loss.

Buying a complete supply of the road steel you need for the job at hand from Bethlehem Steel Company means that you can count on having the steel you want when you want it. Your order, regardless of its size, is handled as a unit with every detail properly coordinated. Shipping dates are planned and met according to your own requirements. You need waste no time checking up on shipments—run no risk of having to pay penalties due to unforeseen delays.

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Observations by the Way

By A. PUDDLE JUMPER

¶ Pavement shoulder work in Pennsylvania west of Uniontown. Rock

is tamped into trench along edge of slab and then bituminized. Note stakes set to get straight grading job.

• •

¶ I notice where some roads are finally getting a safety line painted along the edges.

• •

¶ Protection to newly painted center line markings on Ohio roads where sight distance is short is accomplished by spacing short red flags along it.

• •

¶ One of the obstacles that increase maintenance costs on highways as well as mar the beauty of the road are the numberless mail boxes nailed on to posts driven or set in the shoulder. Newspapers are frequent offenders. Remove them!

• •

¶ To me it was a surprise to see that freight train rolling through the business section of Uniontown, Pa.

• •

¶ I suggest that the Chamber of Commerce of Port Clinton, Ohio, remove that sign near the east city limit which reads as follows: "Ohio's Gateway to Scenic Beauty." If the beauty of the state is no more scenic than the worn out, rough, narrow pavement that constitutes the gate I certainly would not advertise the fact.

• •

¶ Let's buy Ontario province from Canada. It ought to be a part of the United States anyway.

• •

¶ Why doesn't the federal government have a specification for preformed wire rope alone so that preformed may be bid as a separate type?

• •

¶ What's a "Hatchet Man" in a state highway department? Callahan or Botts of the contracting firm in Baltimore bearing their names can give one answer. Or else ask Bob Reindollar, Assistant Chief Engineer of the Maryland State Roads Commission.

• •

¶ Approximately 2,000 employes of the Minnesota highway department, stationed throughout the state, took final examinations last month in first aid courses which had been in progress for ten weeks. Because highway employes are continually on the roads and often are first at the scene of traffic accidents, it is believed that they should be qualified to give first aid in such emergencies.

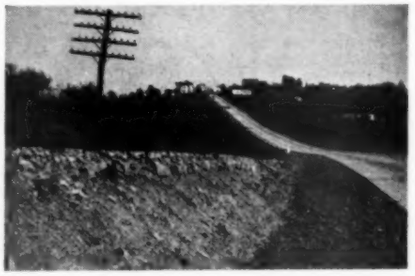
¶ Illuminated signs on important junctions of New Jersey's highways

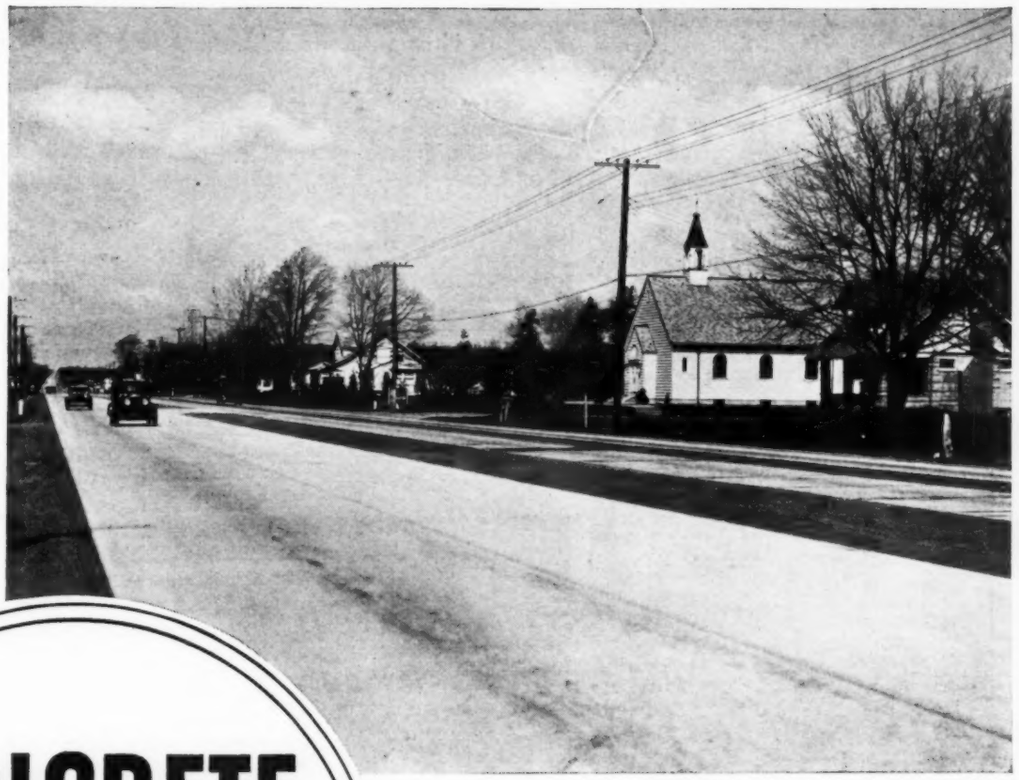
guide the night driver and leave him with a feeling of security that he is on the right road. This practice could be extended to many other states advantageously. This picture was taken at 11:00 p. m. on a rainy night.

• •

¶ Showing construction development of many roads in the eastern states. In an effort to preserve original investment and to keep pace with increased traffic demands the black top road evolved. The pictures show how the Telford base was placed and their MacAdam's idea of crushed rock superimposed upon it. This served horse drawn vehicles and a few motor vehicles. Later motor

vehicle traffic demanded dustless and smoother surfaces so the water-bound macadam roads were surface treated with bituminous materials. Higher speeds and denser traffic





Scene on Albany-Schenectady road near Albany, recently "double-tracked" for 7½ miles by the addition of a second 2-lane concrete roadway separated from the old pavement by a 12-ft. parkway.

CONCRETE

helps engineers design safer roads

CONCRETE lends itself ideally to safer roads. It permits the engineer to add to the safety value of grade separations, modern alignment, adequate widths, ample sight distances and uniform traffic signs, by providing also *the safest possible pavement surface.*

Concrete's gritty texture assures maximum braking efficiency, wet or dry. Its light grey color and well-defined edges increase the effectiveness both of street illumination and of car lights. Its flat crown makes the whole road usable. Its true, even surface reduces motoring fatigue and mechanical failures. And concrete is economical because it costs less than other roads of equal load-bearing capacity and saves hundreds of dollars per mile annually in surface maintenance.

Let us help you design your next road with safe and satisfying concrete. We'll send any or all of the volumes in the Concrete Pavement Library—(1) "Rational Planning of a Public Highway Program"; (2) "Concrete Road Design Simplified and Correlated with Traffic"; (3) "Short Count Traffic Surveys"; (4) "What Old Concrete Roads Tell Us"; (5) "Concrete Pavement Manual."

PORTLAND CEMENT ASSOCIATION

Dept. A11-28, 33 West Grand Avenue, Chicago, Ill.

volumes demanded less curvature and greater sight distance. The portland cement concrete road shown replaced the gradually evolved bituminous treated road. These pictures were taken on the National Old Trail in Pennsylvania.

• •

¶ State planning survey traffic station south of Galion, Ohio. Traffic officer shown instructing car driver to mail card he has just given the driver asking for starting place and

destination of the trip. All trucks are weighed by portable scales. The upper picture shows the recorder with the squad car.

• •

¶ Those asphalt paving machines certainly did a nice job on the Cleveland airport runways.

• •

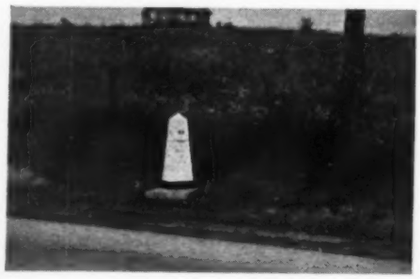
¶ I see no reason why adequate surfaced roads can not be provided throughout the nation if available local materials are utilized to the fullest extent practicable.—H. H. Houk, Chief Engineer, Alabama State Highway Department.

• •

¶ During the fiscal year ended June 30, 1936, there was completed under the administration of the U. S. Bureau of Public Roads with federal aid and emergency funds 1,656 miles of surface treated roads, 1,606 miles of low cost bituminous mix, 256 miles of bituminous macadam and 417 miles of bituminous concrete.

• •

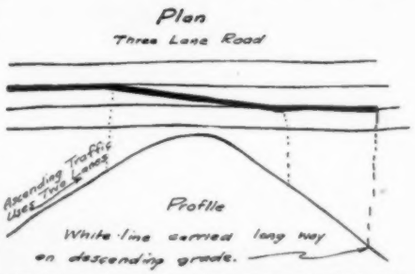
¶ National Old Trail milestone in Ohio. The marker is fashioned out of limestone and placed at mile points



along the right of way. This one is located just west of Martin Ferry, Ohio, and Wheeling, West Virginia.

• •

¶ "Concerning the surface marking on the Belair Road, the part between Baltimore and Belair, Md., we endeavored to mark a three-lane road in this instance, affording sight distances at all times of 1,000 ft. Vertical and horizontal curves on this road are such that if center lane striping had been used to establish 1,000 ft. sight line distances, practically two-thirds of the road, although constructed as a three-lane road, would be limited to two-way traffic. In order to overcome this and to make every foot of the road available to three-way traffic, we decided to put the white diagonal strips over the brows of hills and confine traffic to a single line on descending grades to such a point as the 1,000 ft. sight



Marking on a 3-Lane Road Near Belair, Md.

line would be established. In doing this, we gave, in every instance, traffic on ascending grades the use of two lanes so that the fast moving vehicle on the grade would have no difficulty in passing the slower moving vehicle."

The portion in quotes is an explanation of the traffic lining on Maryland's main traveled three-lane road between Baltimore and Philadelphia. The accompanying sketch shows how the markings are painted.

• •

¶ National Old Trail milestone in Pennsylvania. These markers are built of concrete and placed inside the right of way line of the road at mile points. These markers are provided with a bushy background.

MOVING MOUNTAINS—Hercules Power follows the engineer around the world—moving mountains of dirt and rock, smoothing the path for traffic—in man's conquest of nature.

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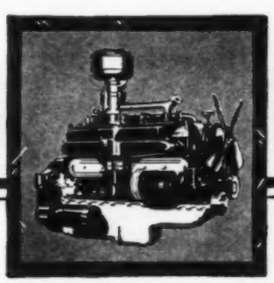


Yes—We would like you to mention ROADS AND STREETS

EDITORIAL

Federal Highway System

THIS editorial advocates the adoption of a federal highway system separate from the state or county highway systems. We believe the federal government should adopt a limited mileage, of roads to be constructed, maintained and policed by the United States. It is immediately acknowledged that the selected roads may not touch all states and therefore a political problem would be presented. On the other hand we believe it can be shown that such a system would be advantageous and economically justifiable.

In 1827 the United States was rapidly expanding its western frontier. The greater percentage of the population was east of the western edge of the Appalachian Mountain area. The main routes of travel westward in the development of the West were national roads. Following is a quotation from the Annual Address to Congress of President John Quincy Adams on December 4, 1827:

"The expediency of providing for additional numbers of officers in the two Corps of Engineers will, in some degree, depend upon the number and extent of the objects of national importance upon which Congress may think it proper that surveys should be made, conformably to the act of the 30th of April, 1824. Of the surveys which, before the last session of Congress, had been made under the authority of that Act, reports were made:

"1. Of the Board of Internal Improvement, on the Chesapeake and Ohio Canal.

"2. On the continuance of the National Road from Cumberland to the tide waters within the District of Columbia.

"3. On the continuation of the National Road from Canton to Zanesville.

"4. On the location of the National Road from Zanesville to Columbus.

"5. On the continuation of the same road to the seat of government in Missouri.

"6. On a Post Road from Baltimore to Philadelphia.

"7. Of a survey of Kennebec River (in part).

"8. On a National Road from Washington to Buffalo.

"9. On the survey of Saugatuck Harbor and River.

"10. On a canal from Lake Pontchartrain to the Mississippi River.

"11. On surveys at Edgartown, Newburyport, and Hyannis Harbor.

"12. On survey of LaPlaisance Bay in the Territory of Michigan."

From the above it is readily seen that from the earliest days of the republic the importance of federal roads was recognized.

There are several points that argue favorably for a federal highway system. They are:

1. National defense.
2. Territorial interconnection with high speed travel.
3. Large amount of interstate traffic, both pleasure and business.
4. Relief for congested conditions in certain places on certain main east-west arteries and some north-south arteries.
5. Linking of national parks, shrines and historic spots.
6. Simplified cross country routing for vacationist travel and tourist traffic.
7. Divorcement from local political conditions and establishment of uniformity of administration.

The War Department has already adopted a road net for national defense which it has divided into three categories, viz., First Priority, Second Priority and Third Priority highways. Its purpose in doing this was to make recommendations as a guide for the Bureau of Public Roads in the approval of projects as they develop. For tactical reasons roads employed for national defense are much more valuable to a field commander if they by-pass all centers of population; troops can be more expeditiously moved and supplies more easily transported One of the principal characteristics of a federal system would be the by-passing of cities and towns.

On a system of federal highways there need be no upper limit of speed but a lower limit of 45 miles an hour should be enforced. These roads could be so located as to connect the various parts or sections of the country, South with West, Middle West with New England and West Coast with Eastern Seaboard.

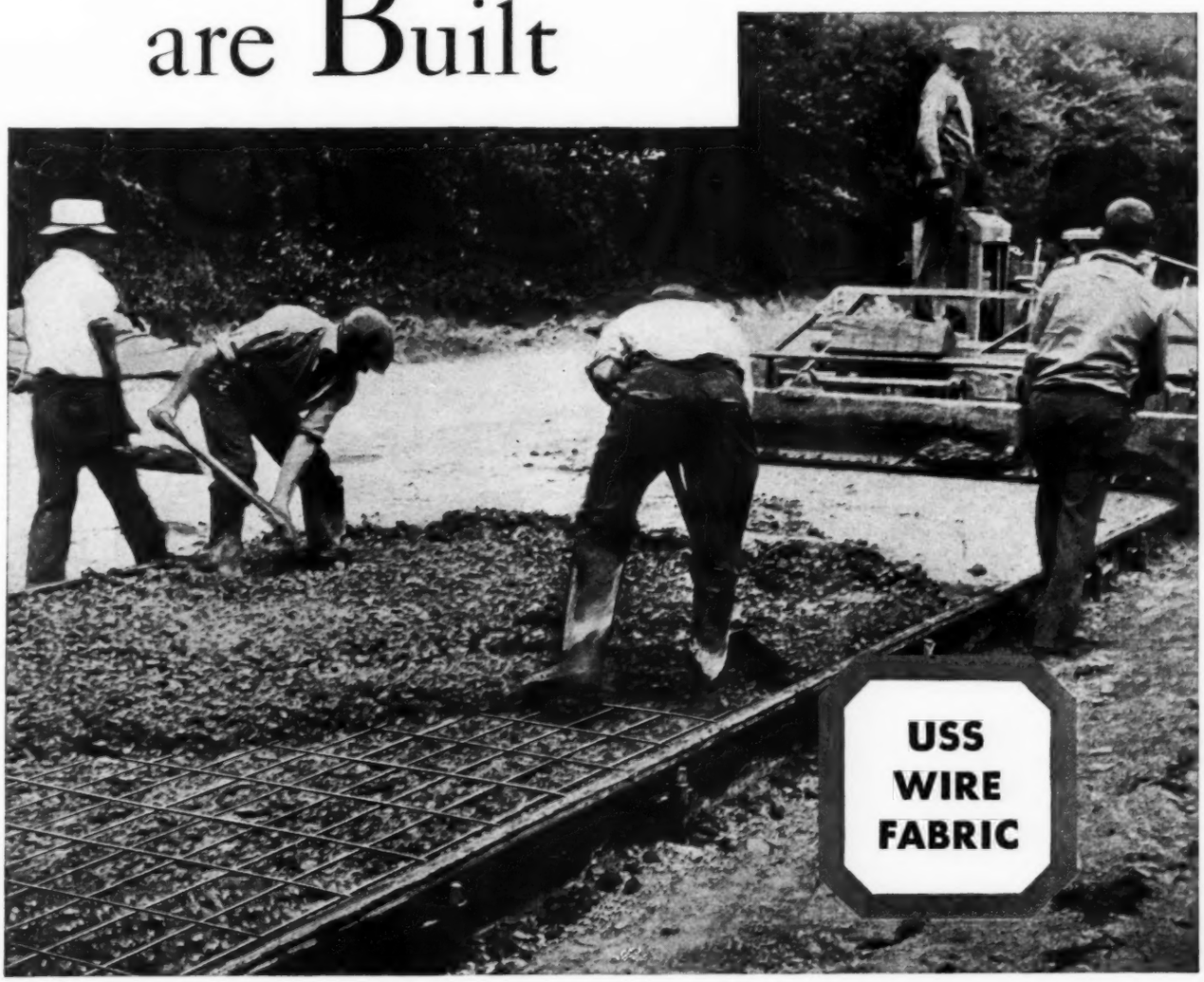
The federal highway system would be the catalytic agent in the American Melting Pot. It would be the fusion rod of the welding process.

The national highway planning survey, now in progress in most of the states, could be analyzed to show the density of interstate traffic. One needs only to travel the nation's highways to convince himself that interstate traffic today is a large amount of the whole travel. The present highway travelers also know how congested certain main routes are. To note this condition in particular, drive from Chicago to Buffalo or any eastern city by skirting the south side of Lake Erie. Also drive from Boston to Washington, D. C.

A social value will be embodied when national parks, national forests, and national shrines are linked to the federal system. Patriotism and respect for other generations are developed by personal contact with historical places.

Another important feature of a federal system of highways will be the uniformity of administration on all sections of the system in the various parts of the country. Construction and maintenance will not be influenced by local politics and the policy of construction of economically justifiable highway surfaces can be applied. A definite policy of construction by contract should be fundamental in the program. The federal act that establishes a federal highway system should contain a provision that all work be done on a contract basis. The system advocated in this editorial is not necessarily the system of roads constructed by federal aid to states although in places the two systems might overlap. The writer, however, would prefer to see locations adopted on which no surfaced roads exist at present. In other words, we would prefer to see a federal system of highways, by-passing all cities and towns, superimposed upon the present road net. From Milwaukee, Wis., around the end of Lake Michigan east to a point near Philadelphia the road might well be a dual highway. From Boston to Washington, D. C., by-passing all cities the road should be a dual highway.

Here's how *Better* Roads are Built



HIGHWAY construction is expensive. When highways are built they must be constructed so that they will last under heavy punishment in all kinds of weather conditions, otherwise the money is wasted. The use of Wire Fabric has become one of the most important factors in strengthening concrete construction.

Wire Fabric more than pays for itself in the added life it gives to highways. It binds the concrete together and helps prevent cracks . . . when cracks do appear it prevents them from spreading. Binding the concrete together forms a strong rigid unit which resists frost heaves and settling.

American Steel & Wire Company Wire Fabric is available for quick delivery in either sheets or rolls. Its use will help you build highways that last longer and cost less to maintain.

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UNITED STATES STEEL

NEW EQUIPMENT AND MATERIALS

New Hug Truck

The Hug Co., Highland, Ill., has announced their new Model 30 Hug Lugger with "Show Down" Caterpillar diesel engine. Using low cost diesel fuels, unusually economical operation is claimed for this new hauling unit. The engine is the Caterpillar D8800 diesel, 4-cycle, water cooled, with a displacement of 831 cu. in. and A. M. A. rating of 52.9. Transmission provides 12 speeds forward and three reverse. The Hug setback wheel design allows exceptionally short turning radius and ease of handling.

Model 30 Hug Lugger

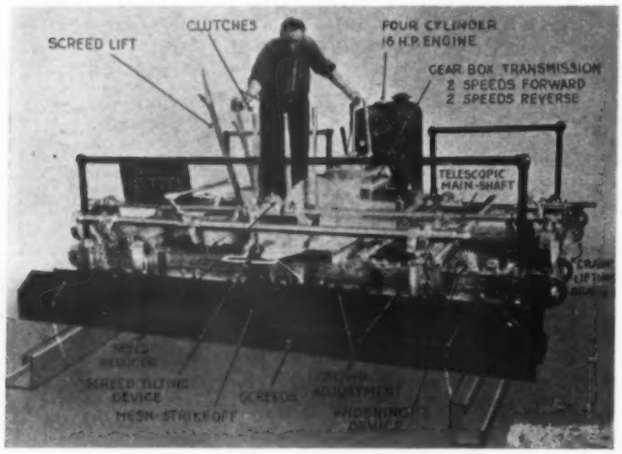
Many innovations in design and construction are incorporated in the chassis of the new Hug Lugger. The entire Model 30 Hug Lugger frame is electrically arc welded. Trusses, spring hangers, motor hangers, radius rod braces and box section cross members are all electrically arc welded to the side rails, forming one rigid structure.

The body is the Hug "Scoop End" body with direct reversible high dumping angle hoist. There is no tail gate and the body sides are re-inforced with "I" beam steel ribs. Body is of 10-yd. capacity and the maximum pay load of the unit is 30,000 lb.

▼

New Finishing Machine

A new Panama type Flex-Plane finishing machine has been announced by the Flexible Road Joint Machine Co., Warren, O. Designed for full width construction, a Flex-Plane machine is adjustable from 18 o 30 feet; for half width construction, 9 to 16 feet—standard equipment.



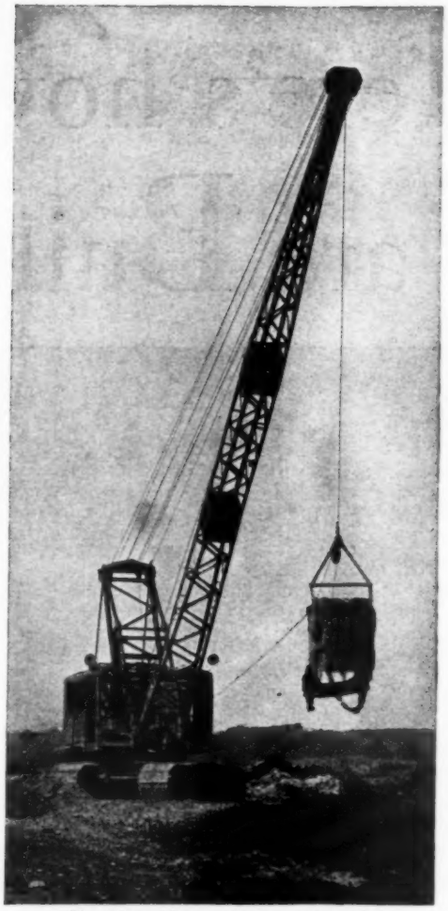
New Panama Type Flex-Plane Finishing Machine

This machine screeds backward, as well as forward. It is equipped with built-in gear box transmission, two speeds forward and two reverse, 16 H. P. four-cylinder engine, belting attachment, reinforcing mesh strike-off attachment, and quick adjusting crown attachment on the screed.

▼

New Series of Draglines

A new series of dragline models, especially designed for long range operation is now being offered by Koehring Co., 3026 W. Concordia Ave., Milwaukee, Wis. These long range draglines, Models 702 and 802, are designed particularly for a wide range of operating flexibility. Faster than ordinary speeds, with ample power, tough digging assures high production. Economy of operation and low upkeep cost are important features of these new machines.



Koehring Long Range Dragline

Long booms, proper stability and extra wide and long crawlers are outstanding features. The exclusive Koehring swiveling boom point fairlead materially reduces cable wear.

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Puncture-Proof Inner Tube

A patent covering an inner tube which seals punctures in tires while the car is in motion has been issued to The B. F. Goodrich Co., Akron, O.

The puncture-proof inner tube is made with a layer of plastic self-sealing composition on the inner side of the tube. Holes are closed without loss of air when the penetrating object is removed.

The Goodrich product, known as the Seal-O-Matic tube, has been subjected to more than four years of actual road service on thousands of passenger cars and trucks, according to the manufacturer.

In a number of instances reported to the company users have removed scores of nails, screws and other articles from tires after months of uninterrupted operation and without loss of air pressure. The new tube is moderately priced.

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New Pavement Breaker

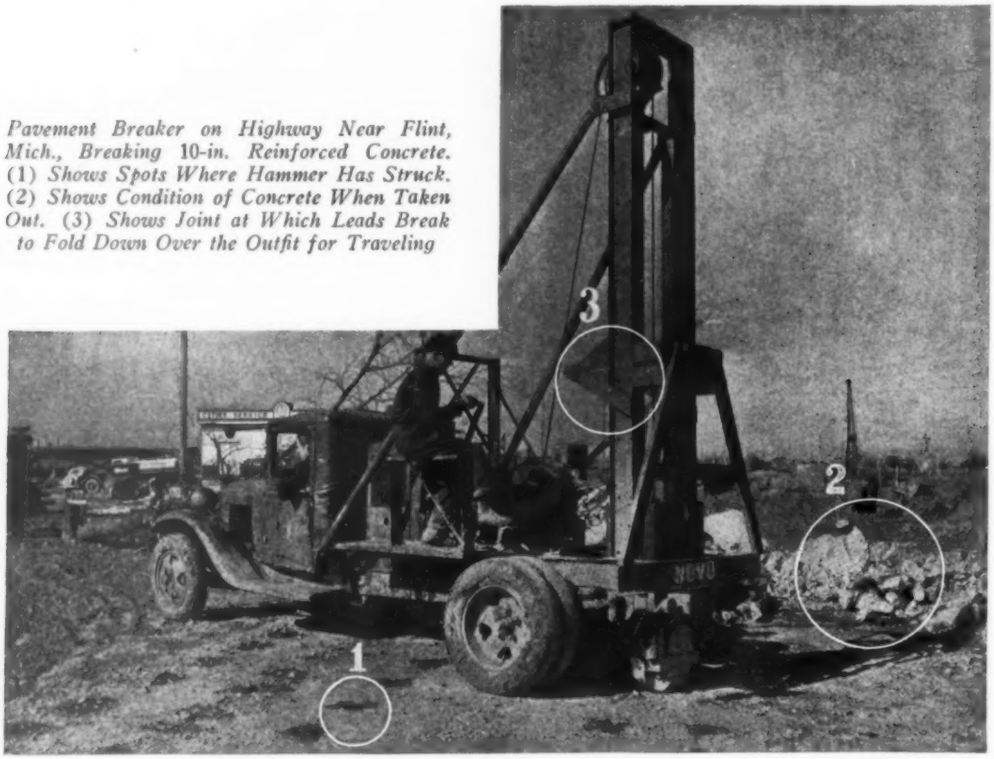
A highly mobile pavement breaker has been brought out by the Novo Engine Co., Lansing, Mich. The demolishing hammer can be fitted with various breaking noses which will break the concrete to specifications depending upon the use it is to be put after it is broken. It is stated that uniform pieces from 6 in. to man-size can be broken.

The breaking nose can be replaced with a cutting knife which, it is stated, will cut asphalt on a hair line for pipe line excavation or between car tracks, and also can be used for trimming the edges of pavement or widening jobs.

For the majority of breaking jobs the hammer usually has to be raised but 3 ft., thus increasing the number of blows that can be struck in a given time.

The outfit can be installed on any standard 1½-ton or larger motor truck having a length of at least 126 in. from back of cab to end of truck frame. When the outfit is in transit the hammer is carried in low position at bottom of leads. The frame is hinged half way up to allow for lowering to traveling position.

Pavement Breaker on Highway Near Flint, Mich., Breaking 10-in. Reinforced Concrete. (1) Shows Spots Where Hammer Has Struck. (2) Shows Condition of Concrete When Taken Out. (3) Shows Joint at Which Leads Break to Fold Down Over the Outfit for Traveling



New Truck Air Compressor

A new line of truck air compressors is now available from the Le Roi Co., Milwaukee, Wis. This company manufactures three sizes of compressors, 85, 105, 160 cu. ft. capacity, free air at 100 lb. pressure. The compressors can be operated from any current make or model truck by means of a split shaft power take-off used, which is manufactured by the Hercules Steel Products Co., Galion, O.

The 85 and 105 cu. ft. compressors can be operated from any 1½-ton truck. The 160 cu. ft. compressor requires a truck of 2½ to 4 ton capacity.

Le Roi has designed the complete line especially for truck motor operations, accounting for the difference in operation of truck jobs, as compared to the standard portable type compressors. Perfect balance has been accomplished between the compressor and the truck motor, which is claimed to assure the purchaser of a completely engineered truck air unit. Some models required only 29 in. space back of cab. Special construction makes it unnecessary to cover the compressor for weather protection. Special belt tightening arrangements exclusively used by Le Roi. Special bodies can be secured from the Le Roi Co. to be used in connection with the compressor mountings.

Lee Roi Truck Air Compressor

New 1-Yard Excavator

A new high-speed excavator, Diesel or gasoline powered, known as the Model 455 with 1-yd. capacity and equipped with tractor-type crawlers, is announced by the Harnischfeger Corporation of Milwaukee, Wis. Specifically designed as an all-purpose machine, the weight of the 455 is radically reduced by the use of new high-tensile steels and electric welding.

New P & H Model 455

Standard tractor crawlers of the type manufactured by the Allis-Chalmers Co. are used on the machine. Quieter, yet more efficient, power is secured by the use of helical-cut gears in both reductions of the hoist mechanism. Two speeds assure accurate inch-spotting, so necessary in such crane work as the placing of structural steels without the necessity for re-reeving the hoist cable.

Two hook rollers are used on the front edge of the live roller circle and four swivel hook rollers on the tipping edge to counteract all strains and eliminate pull on the center pin to permit fast, easy swing with the heaviest dipper loads.

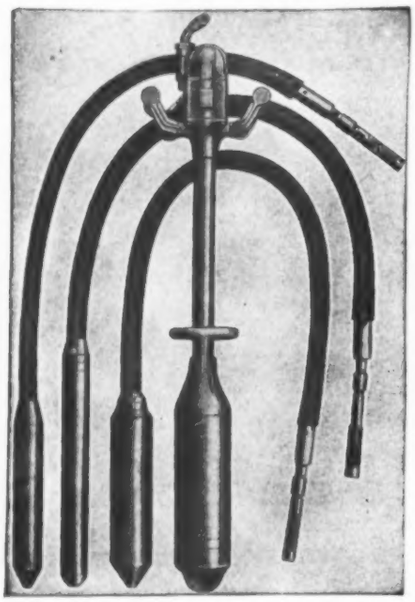
Fast and easy control is increased by the use of the popular automotive type of foot pedals which operate the larger brakes

and clutches of the Model 455. The hand levers are easily reached, and easily manipulated by the operator's natural strength. Following the lines of the popular Bantam Weight machines, this model 455 has a full-vision cab and ample space for engine inspection and plenty of room for the operator.

This model is provided with 2-speed transmission for every movement in travel and digging.

New Concrete Vibrators

A new line of concrete vibrators has been brought out by the Chicago Pneumatic Tool Co., 6 East 44th St., New York. Four models are included in the line.



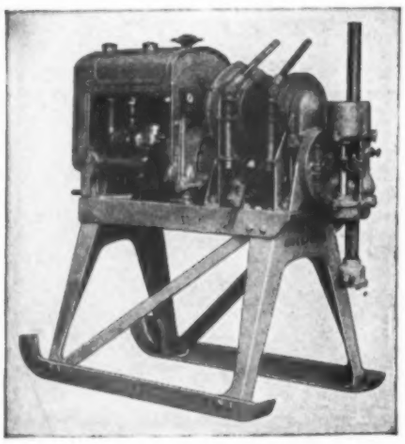
Models 315, 325, 418 and 518

Model 518 is specially designed for vibrating heavy concrete in dams and large bridge piers, abutments, footings, etc. In this model the motor is placed at the upper end of a short tube connecting it to this vibrator tube, thus giving balance to the tool and making it easy to handle. The overall length is 4 ft. and the vibrating tube has a diameter of 5½ in. and a length of 15 in. The rated capacity is 35-40 cu. yds. per hour. The weight is 65 lbs.

Model 315 has been designed for vibrating concrete above 3 in. slump. This is a 3 in. vibrator for use in thin walls, floor and roof slabs, columns, pile castings, etc. It has a rated capacity of 10-15 cu. yd. per hour. It weighs 30 lb. The length of the vibrating tube is 17 in. Model 325 has the same diameter vibrator as Model 315, but it is 8 in. longer and more powerful. It has a capacity of 20-25 cu. yd. per hour. Model 418 is designed for the heavier concretes. It has a 4 in. vibrator and an 18 in. long vibrating tube. It weighs 45 lb., and has a capacity of 25-30 cu. yd. per hour.

New Light Weight Core Drill

Smallest of the Sullivan family of core drills, the new No. 12 has a 50 per cent increase in drilling speed. This adaptable light weight machine is 4 ft. 7 in. high and weighs little over 1000 lb.

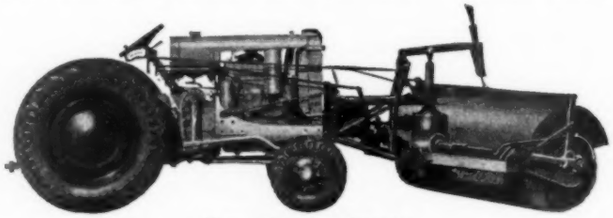


New No. 12 Core Drill

Four compact parts — hoist, engine, swivel-head and frame—can be quickly dismantled for easy transportation. Reserve strength is built into every part to overcome any possibility of breakdown. Hydraulic or screw feed swivelhead which can be set for drilling at any desired angle. Variable speeds make efficient operation possible in either soft or hard formation. Gasoline or electric drive. Bulletin D-10 can be obtained from the Sullivan Machinery Co., Michigan City, Ind.

New Tractor Sweeper

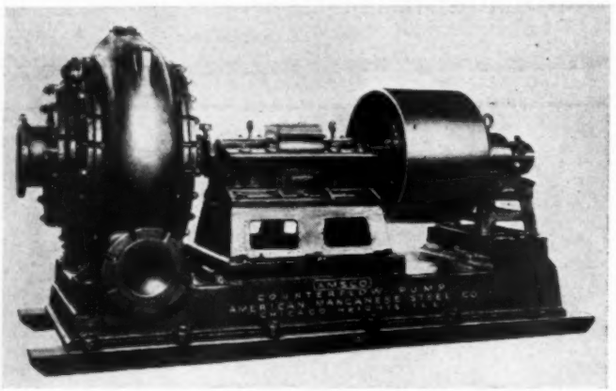
The Frank G. Hough Co., 919 North Michigan Ave., Chicago, Ill., are now in production on their new Tu-Way tractor sweepers. These machines have been in use for years for snow sweeping by municipalities, parks, cemeteries, large industrial plants, etc., etc. This new model incorporates many improvements and refinements such as ball and roller bearings, fully enclosed gear boxes and the exclusive two-direction brush which permits sweeping either to the right or to the left.



New Tractor Sweeper

Amsco "Counterflow" Pump

A major design improvement in the "Counterflow" pump is now offered by the American Manganese Steel Co., 406 East 14th St., Chicago Heights, Ill., makers of abrasive material handling pumps. The pump is stated to combine several new design advantages with the correct application of manganese steel.



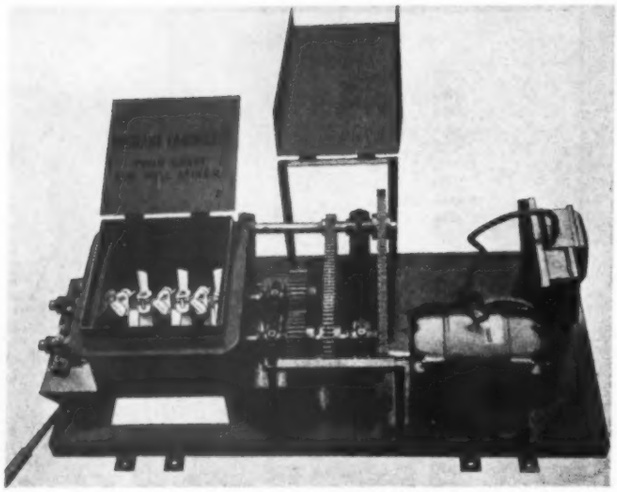
Amsco Counterflow Pump

The "Counterflow" pump features: a wide funnel-mouth impeller; threading of the impeller bore; elimination of internal leakage; and most important—greatly reduced internal wear accomplished by providing clear water, under pressure between the impeller shrouds and the shell side plates. This AMSCO feature introduces clear water between the shrouds and plates with a "counterflow" action, replacing sand-laden water which is a cutting compound, with clear water which is a lubricant—thus the name, the Amsco "Counterflow" pump.

This new design is not only available in all sizes and types of new Amsco pumps, but it is also stated that practically all pumps now in service may be converted at nominal cost to take advantage of "Counterflow" features.

Laboratory Pug Mill Mixer for Trial Bituminous Batches

A mixer, for laboratory use, that enables the engineer or chemist to mix small bituminous batches that can be laid and plotted for actual observation under various traffic conditions has been placed on the market by Frank B. McGrane, 44 Bigelow Street, Quincy, Mass. The mixer mixes a batch of 40 lb. or less. With it a proposed mixture is made up and laid in patches at the designated points on streets or highways of



McGrane Laboratory Pug-Mill Mixer

a particular classification. Patches are plotted; observations are made from time to time from which the engineers can arrive at satisfactory conclusions as to the merits of their combinations.

The unit of the mixer is driven by a totally enclosed 1½-hp. motor. Reduction is from 1200 r.p.m. to 70 r.p.m. through silent and roller chain. The roller has manganese plate liners, high carbon steel shafts, special process steel mixing blades and stuffing boxes.

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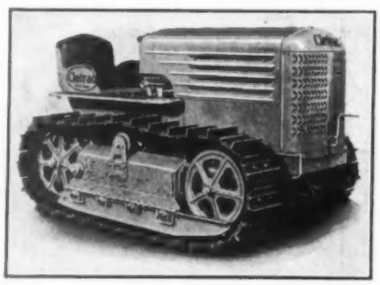
Cletrac Streamlined Crawler Tractors

Giving new grace and beauty to mobile power units that have until now been built for endurance rather than eye appeal, for utility more than style, the new streamline design of the crawler tractors of the Cleveland Tractor Co., Cleveland, O., eliminates sharp corners and projections and puts Cletracs in a new style class.



New Cletrac Streamlined Tractor

Comfort for the operator is provided in coil - spring - cushioned seat, adjustable foot rests and controls that are stated to make Cletrac operation as easy as driving a team. Exhaust and intake are hidden from view.

The Cletrac patented features such as controlled differential steering, one piece drop-forged shoe, track support and lubrication design and the frame construction are the same as before.

Details of the streamlined Cletracs are given in a new booklet now on the press. The Cletrac line includes crawler tractors from 22 to 94 drawbar horsepower, powered with internal combustion and diesel engines.

▼

New Steam Driven Compressor

Sullivan Machinery Co., Michigan City, Ind., has developed a new single stage steam driven horizontal compressor — Class WA-7 — for steam pressures 80 to 250 lb., air pressures up to 150 lb., sizes 279 to 1987 CFM.

The WA-7 is a heavy duty single cylinder double acting unit for either air or gas compression. The steam cylinder is placed in tandem with the air cylinder next to the frame and is heavily lagged for steam economy. The steam valve is of the balanced piston type with inlet pressure in the middle so that the valve rod box is sealed against exhaust pressure only. A variety of controls is available to provide greatest economy under each operating condition: throttling fly-ball governor for steady steam and air pressure; fly-wheel governor for variable steam with steady air pressure, etc. Timken double row main bearings, force feed lubrication, special cast alloy air cylinder liner and valves with laminated cushion backs are features which add to efficiency.

For more complete data ask for Bulletin A-14, Sullivan Machinery Co., Michigan City, Ind.

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WITH THE MANUFACTURERS

Chicago Pneumatic Promotions

Effective Oct. 1, W. C. Straub, formerly Manager of the New York Branch Office, was appointed assistant to executive vice president. Also effective Oct. 1, A. D. Stem was appointed manager of the New York Branch Office to succeed W. C. Straub.

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Aeroil Burner Opens Dallas, Tex., Office

The Aeroil Burner Co., Inc., West New York, N. J., has opened a new sales office and warehouse at 3408 Main St., Dallas, Tex. The office is in charge of Thomas Herndon, and will offer sales and service on the complete line of weed burners, asphalt heaters, emulsion sprayout fits, lead melting furnaces, heating, thawing and disinfecting torches and other industrial oil-burning equipment.

▼

Thomas A. Boivin Killed in Crash

The many friends of Thomas A. Boivin, proprietor of the Upper Peninsula Tractor Co., L'Anse, Mich., are mourning his tragic death as a result of an automobile crash near L'Anse, September 21. Mr. Boivin was driving his sedan toward L'Anse when the machine and a logging truck collided. The truck driver was killed instantly. Mr. Boivin died in Ford hospital, L'Anse, soon afterward.

Mr. Boivin was a pioneer in the development and marketing of snow removal equipment, and was active in demonstrations and trials of tractor-plow units. He, with his brother, Louis, formed the Upper Peninsula Tractor Co. in 1918, becoming distributor for Caterpillar Tractor Co. products. Since his brother's death three years ago he had been sole proprietor.

A familiar figure at meetings of road commissions and boards of public works, Mr. Boivin was known throughout the northern peninsula. He was also widely acquainted in north central logging areas. He was 54 years old.

Surviving are the widow, a brother and two sisters. Funeral services were said to have been the largest held in L'Anse in many years.

▼

Hercules Appoints Oklahoma Distributor

The Hercules Co., Marion, O., has appointed the Wylie-Stewart Machinery Co. of Oklahoma City, Okla, as Hercules roller distributors for the state of Oklahoma. They will handle the complete Hercules roller line including the Hercules ironer roll and will give state wide coverage on sales and service.

▼

Cletrac Appointment

C. W. Garrison has resigned as account executive for the Burns-Hall Advertising Agency, Milwaukee, Wis., to become advertising and sales promotion manager of The Cleveland Tractor Co., Cleveland, O. Preceding his connection with Burns-Hall, Mr. Garrison was a director and account executive of Freeze-Vogel-Crawford, Milwaukee advertising agency, in which capacity he served the Allis-Chalmers Mfg. Co. tractor and texrope drive divisions, in addition to manufacturers of other industrial equipment.

Novo Appoints New Sales Manager

According to an announcement by B. P. Teel, vice president and general manager of the Novo Engine Co., Lansing, Mich., R. B. Harvey has been appointed general sales manager of that company.

Mr. Harvey has been with the Novo Engine Co. for nine years, all of which time has been spent in charge of the Central Sales district, which includes a large portion of the United States and Canada. In covering this territory Mr. Harvey has become well acquainted with the equipment distributors and manufacturers and has acquired an understanding of their problems as well as those of the various types of contractors. He is especially well fitted for his new duties, as his background covers a sequence of activities in the engineering and industrial fields.

R. B. Harvey

Mr. Harvery after graduating in engineering from the University of Delaware served as an apprentice in the shop of the Westinghouse Electric and Manufacturing Co. At the end of five years he was appointed manager of a sales section of that company. During the World War Mr. Harvey served in the United States Air Corps as a pilot and flying instructor. It is his plan to follow out the Novo Engine Co. policy of close contact and cooperation with their equipment distributors in the United States and Canada, which number over 80 at the present time.

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Kentucky Rock Asphalt Broadcasting

Beginning Sunday evening, Oct. 11, 1936, between 6:15 and 6:30 p. m., C. S. T., and continuing every Sunday thereafter until further notice, the Kentucky Rock Asphalt Institute will broadcast over WHAS (820 kilocycles) the use of Kentucky rock asphalt in the various road and street building programs in the country. In general the program will consist of about ten minutes of music and a five-minute talk by a recognized authority on roadbulding.

▼

Crocombe Now Vice-President American Brake Shoe & Foundry Co.

William E. Crocombe has been elected vice-president of the American Brake Shoe and Foundry Co. He started in the steel business as office boy under Don H. Bacon of the old Minnesota Iron Co., Minnesota Steamship Co., and Duluth and Iron Range Railroad Co. When these companies consolidated with the United States Steel Corporation Mr. Crocombe went to work at the South Works of the Illinois Steel Co. in the rail mill and open hearth departments until 1907. For the period of 1907 to 1909 he was with the Lackawanna Steel Co. at Buffalo, N. Y., in the open hearth department. From 1909 to 1915 he was connected with the Union Drop Forge Co. at Chicago. In 1915 Mr. Crocombe organized the forge department of the Ajax Forge Co., now known as the American Forge Division of the American Brake Shoe and Foundry Co. Mr. Crocombe was elected president of the American Forge Co. in 1924 and president of the American Manganese Steel Co. in 1933, both these companies being important divisions of the American Brake Shoe and Foundry Co.

W. E. Crocombe

▼

Gar Wood Erects New Plant for Road-Building Machinery Production

A new manufacturing building is now being constructed for Gar Wood Industries, Inc., in Highland Park, Mich. The structure which will be completed in November, will be used entirely for the manufacture of Gar Wood roadbuilding machinery. The rapid expansion of the business of this division, necessitated larger manufacturing facilities, he stated.

The new fireproof building has a concrete floor, 60 ft. by 180 ft., and is being fabricated with structural steel and brick. The expansive front, side, and rear wall areas are designed for glass—Fenestra steel sash is being installed—to provide workmen with floods of daylight inside the building. In addition, the overhead lighting system produces brilliant light, practically devoid of shadows. A model No. 105 Gar Wood Tempered-Aire system will heat and air condition the plant.

Two transformers are to supply sufficient horse power to serve some 50 arc welding machines. An enclosed Buss-Duct system is being installed on each side, and along the entire length of the building. This novel system permits progressive manufacturing. The electrical taps are to be placed at 20-in. intervals for plugging in the welding machines conveniently during working operations.

New Gar Wood Manufacturing Plant Near Completion in Highland Park, Mich.

Raw materials will enter at one end of the building and the work will progress to finished assemblies. The progressive assembly method to be employed is similar to the system used in present-day, motor car manufacture. A 5-ton crane will be installed to move the heavy road-building machinery sections around the plant. A supply of acetylene gas and oxygen will be available at all times. These gases will be piped from acetylene generators and from a group of oxygen tanks located in the nearby main plant. Welding will be used extensively in this Gar Wood plant for fabricating road-building machinery sections.

▼

Slackford Is New P&H Advertising Manager

E. T. Slackford has been appointed advertising manager of the Harnischfeger Corporation of Milwaukee, Wis. A graduate of Ohio State University, Mr. Slackford has spent more than 10 years in industrial engineering and sales promotion work, both with manufacturers and advertising agencies. He is in charge of advertising for the entire P&H line of excavators, cranes, hoists, motors, "Smootharc" welders, and barrel renovating equipment. He succeeds Wood Sanford.

Parrish Appointed Chief Engineer of Buda

The Buda Co., Harvey, Ill., builder of internal combustion engines for over a quarter of a century, announces the appointment of Walter A. Parrish as chief engineer to succeed the late Carl C. Hinkley. Mr. Parrish has had a wide experience in the design and application of industrial, automotive and marine engines. He was graduated from the Detroit Technical Institute in 1910 and shortly after entered the internal combustion engine field with the Hudson Motor Car Co. Mr. Parrish joined the Buda Co. in 1928. The Buda Co. also announces the appointment of L. C. Moxie as assistant chief engineer. Mr. Moxie has been with the Buda Co. since 1922, except for a short time in 1927 and 1928.

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Koppers Gas & Coke Co. Changes Name to Koppers Co.

The name of Koppers Gas & Coke Co., Pittsburgh, Pa., has been changed to Koppers Company. Three subsidiary companies have been or will be dissolved and will become divisions of the parent company. They are: The Koppers Construction Co., which becomes the Engineering and Construction Division; Koppers Products Co., which becomes the Tar and Chemical Division, and The Bartlett Hayward Co., which becomes the Bartlett Hayward Division. The Western gas division of The Koppers Construction Co. becomes a division of Koppers Company, as does the American Hammered Piston Ring Division of The Bartlett Hayward Company. The Maryland Drydock Co., The White Tar Co. of New Jersey, Inc., and The Wood Preserving Corporation remain as subsidiaries of Koppers Company.

Officers of the former subsidiaries will become officers of Koppers Company.

To avoid similarity of titles, the name of The Koppers Company, parent company of Koppers Company, will be changed to Koppers United Company.

Activities of Koppers Company, through its subsidiaries and divisions, include the designing, construction and operation of by-product coke plants, gas producers, tanks, holders and other gas apparatus, wood preserving plants, and dry docks, and the production and sale of motor benzol, ammonium sulphate, naphthalene, phenol, Tarmac road materials, roofing products, tar acid oils, pitch and other coal tar products, machinery and steel mill equipment, piston rings and packing.

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Easton Car & Construction Co. Appoints Cleveland Agent

The Eastern Car & Construction Co. of Easton, Pa., has appointed H. B. Fuller Equipment Co. as agents in the Cleveland territory. The Fuller Company will handle the complete Easton line, including quarry equipment, dump bodies and industrial cars, lift trucks, electric bitumen heaters, railway and industrial turntables, industrial trailers, etc. S. B. Fuller and G. S. Crego, principals in the agency, have long been identified with the quarry and construction industry in Northern Ohio. The addition of Easton products completes an extensive line of equipment handled by the Fuller Agency.

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NEW LITERATURE

High Early Strength Cement—A new manual for high early strength concrete has been issued by the Marquette Cement Manufacturing Co., Marquette Bldg., Chicago, Ill. It brings out by actual photographs, statements of fact, and use of tables and graphs the uses and value of high early strength portland cement in all types of construction, from the smallest to the largest. This 22-page boklet contains much information of interest and value to the engineer and to the contractor. For instance, there is a section on the design of high early strength concrete mixtures and recommended construction practices. There are also several useful tables, one (with a graph) showing compressive strengths of the concrete; another gives recommended water-cement ratios, and two others give quantities by volume of materials and quantities by weight of materials for highway early strength concrete. Write Marquette Cement Manufacturing Co. at the above address for your copy.

Structural Redwood—Structural redwood, with structural design data, illustrations and other information, is featured in an outstanding graphic publication just released by the California Redwood Association, 405 Montgomery St., San Francisco, Calif. The publication illustrates how structural grades of California redwood have been used in important engineering structures.

Draglines—A new bulletin describing its long range draglines, Models 702 and 802, has just been issued by the Koehring Co., 3026 Concordia Ave., Milwaukee, Wis. This bulletin will be gladly mailed to those contractors, operators and engineers interested in large drainage projects, extensive coal mine and quarry stripping projects and wide canal excavation. These machines are especially adaptable for this type of operation. Job illustrations, as well as construction detail photographs with operating specifications, add materially to the interest created by this new publication.

Vibrating Screens—"Data on Controlled Vibration and Screen Efficiency" is the title of a new book released by the Productive Equipment Corporation, 4600 South Kedzie Ave., Chicago, Ill. Complete data on screening and grading in every industry, charts, data and engineering information, as well as a complete description of "Selectro" vibrating screens are covered.

Chains—Two new catalogs filled with practical chain information, including specifications, full size illustrations of many patterns, and other useful facts that help a buyer or specifier to decide just what chain he needs for a specific purpose, have been published by American Chain Company, Inc., Bridgeport, Conn. Catalog No. 365 covers welded chain and attachments from the lighter sizes and types used for fabricating other manufactured articles to the heavier types used for maintenance service and material handling in industrial plants, oil fields, mines, shipyards and on boats. Catalog No. 366 covers weldless chains and attachments. Weldless chains are those made from wire into various patterns by knotting to form the links, or by stamping from flat metal. Weldless chains are used for a host of purposes in the manufacture of many assembled articles. This catalog makes it easy to select just the right size and type of chain for a specific purpose.

Construction Equipment—A new, 24-page bulletin, WP-1061, showing their equipment for contractors is offered by Worthington Pump and Machinery Corporation, Harrison, N. J. This bulletin shows power, compressed air, drilling, pumping and miscellaneous equipment on the job and in the shop. Photographs show Worthington feed-drifters on tunnel work; wagon and rock drills on open cut work; portable compressors furnishing power for various operations; Worthington portable compressors, Rock Masters, and other equipment on highway and street construction; stationary compressors furnishing air for construction work; small compressors for occasional service; diesel and gas engines furnishing power for dredging and other construction operations; pumps for drainage, dewatering, and dredging operations; portable pumping units and heat treating machines for drill steel.

Pumps on Construction Work—In August the Novo Engine Company of Lansing, Mich., issued its Bulletin No. 164, relating to self-priming centrifugal pumps in sizes from 2 to 6 in. The bulletin is on letter size paper punched for binding, and contains essential information as to capacities, dimensions, weight, etc., of this line of pumps for construction use. Illustrations show the unit in service in many odd places on construction jobs. There are condensed tables and rules for figuring friction, horse power,

Public Works Programming—"Outline of Suggested Procedure for Public Works Programming by State Planning Boards" published by the National Resources Committee in cooperation with the Public Works Administration, Works Progress Administration and other Federal agencies in July, is a 36-page mimeographed statement with several folding inserts. It treats briefly of project reporting, general procedure, local procedure, review and rating of projects, and contains a systematic and extensive classification of project details. Highway, road and street projects are treated on pages 20 to 23 of the classification.

Cast Iron—"The Strength and Elastic Properties of Cast Iron," by W. J. Schlick and Bernard A. Moore, Bulletin 127 of the Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa, has been issued recently and is available without charge.

The new bulletin deals with the strength and elastic properties of cast iron in combined tension and flexure, as well as in tension, compression and flexure. A feature of the bulletin is an extensive bibliography of cast iron research and a review of literature.

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with a new line of tractor equipment

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Published Monthly by the
GILLETTE PUBLISHING COMPANY
400 West Madison Street, Chicago, Illinois
Telephone State 5161

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Entered as second-class matter June 25, 1931, at the post office at Chicago, Ill., under the act of March 3, 1879. 15 cents a copy. Annual subscription, $1.00 in the United States and Canada, $2.00 for 3 years; Foreign, $2.00 for 1 year, $3.00 for 2 years.

Vol. 79 DECEMBER, 1936 No. 12

CONTENTS

"Our NEW MARION HAS PROVED ITSELF A VERSATILE AND DEPENDABLE MACHINE" SAYS *E. W. Davis*

PRESIDENT

THE DAVIS CONSTRUCTION COMPANY, Boonville, Missouri

"On the strength of the recommendation of Mr. Stoelting, our General Superintendent, we purchased a Marion Type 331 excavator. Its speedy performance, versatility and ease of handling readily vouched for themselves. On its first job, a railroad overpass and highway approaches, it was used as a shovel to move 60,000 cu. yds. of dirt, as a dragline for handling cement, and as a pile driver for breaking the cement on the old highway. All we can say is that we are mighty pleased with our new Marion—which has handled 80,000 cu. yds. of material to date." « « « « « « «

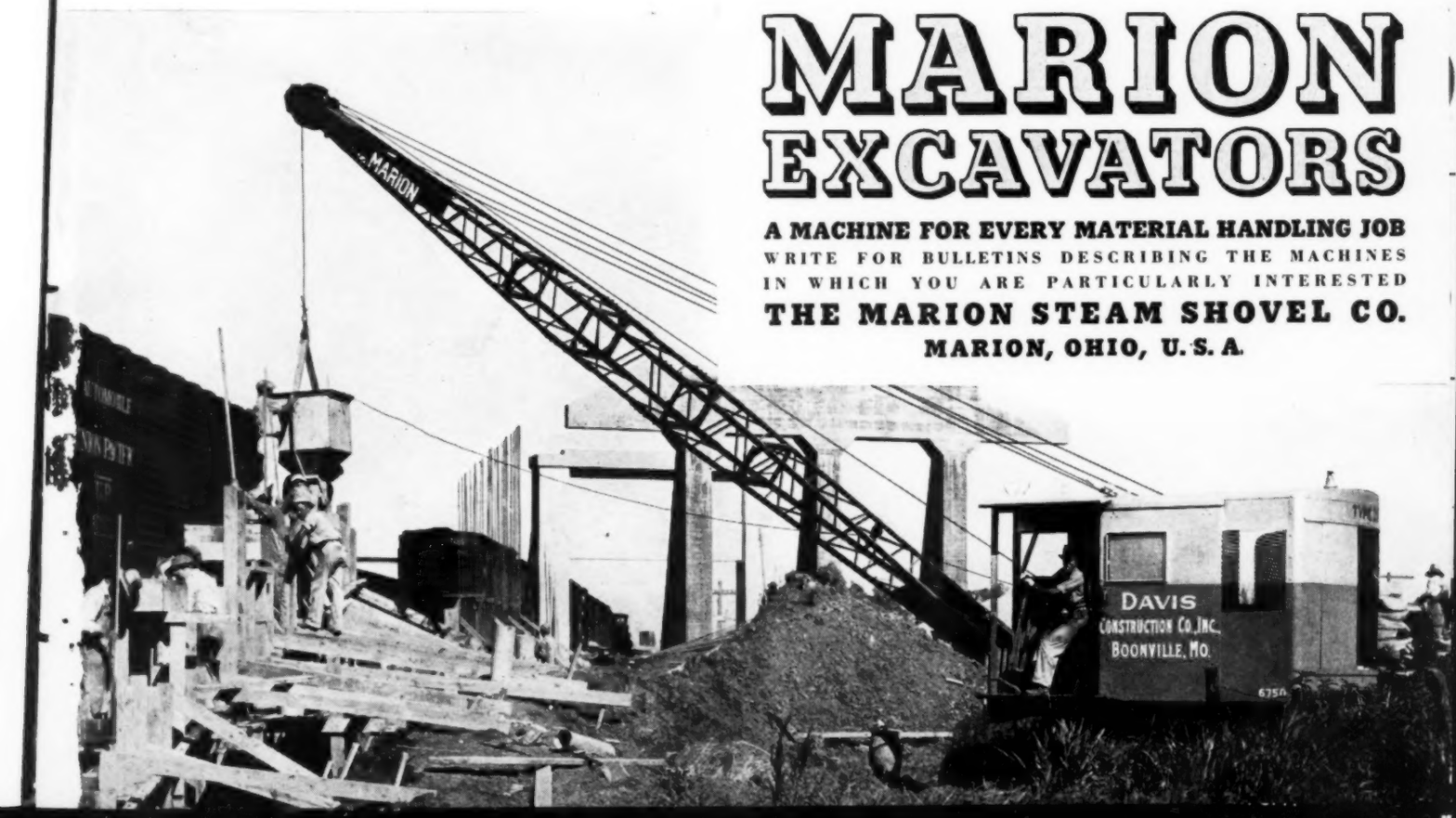
MARION EXCAVATORS

A MACHINE FOR EVERY MATERIAL HANDLING JOB

WRITE FOR BULLETINS DESCRIBING THE MACHINES IN WHICH YOU ARE PARTICULARLY INTERESTED

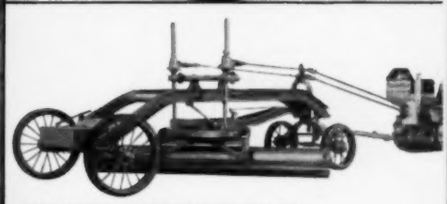
THE MARION STEAM SHOVEL CO.

MARION, OHIO, U. S. A.



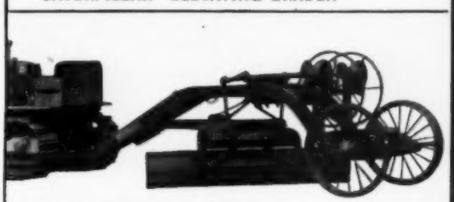
2 MILES A DAY—
AT $1.50 FUEL COST!

"CATERPILLAR" DIESEL AUTO PATROL

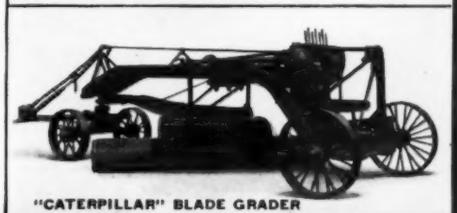


"CATERPILLAR" TRAILER PATROL

"CATERPILLAR" ELEVATING GRADER



"CATERPILLAR" TERRACER



"CATERPILLAR" BLADE GRADER

On county roads in Maryland, this "Caterpillar" Diesel Auto Patrol does a complete maintenance job at a fuel cost of only 73 cents per mile of road completed. Between maintenance jobs, it brings its welcome cost savings to light construction work or snow removal.

Combining the power and low cost of the "Caterpillar" Diesel Engine with the inbuilt strength and accurate control of "Caterpillar" road machinery design, this Diesel Patrol is first choice on the country's roads—doing the job better in fewer trips, providing more miles of good roads for limited budgets. There's a "Caterpillar" dealer near you. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

ROAD MACHINERY

REG. U. S. PAT. OFF.

THE TOOL TO FIT THE

WHICH TYPE FITS YOUR JOB?... MISTAKES ARE COSTLY!

The "best way" to handle one dirt moving job may be far from best on another—that is why it is so important to select "the tool to fit the job." Before you make a decision that might mean the difference between success and failure—check with the man who is best suited to give you an unbiased recommendation. This man is the Allis-Chalmers representative. The fact that he has a COMPLETE line—adapted to ALL types of dirt moving work—enables him to make his recommendation honestly and without prejudice. Your A-C representative is more than a salesman—he is schooled to help you select the proper outfit for the job.

SHORT HAULS

When it's an elevating grader job, here's the winning combination—a Model "L" or "L-O" on the grader and "K's" or "K-O's" on the wagons. This is the J. A. Carlson job near Malvern, Ia.

MEDIUM HAULS

The fast-stepping easy-to-maneuver Allis - Chalmers tractor digs and carries more loads per hour on scraper jobs. These "L-O's" and Continental Scrapers are making 1/3 - mile hauls on the Genesor & Ferguson job near Exeland, Wis.

• • •

Below is a Model "L" and Gar Wood Scraper on the Osborne-Barnes job near Stamford, Conn.

JOB

BULLDOZING

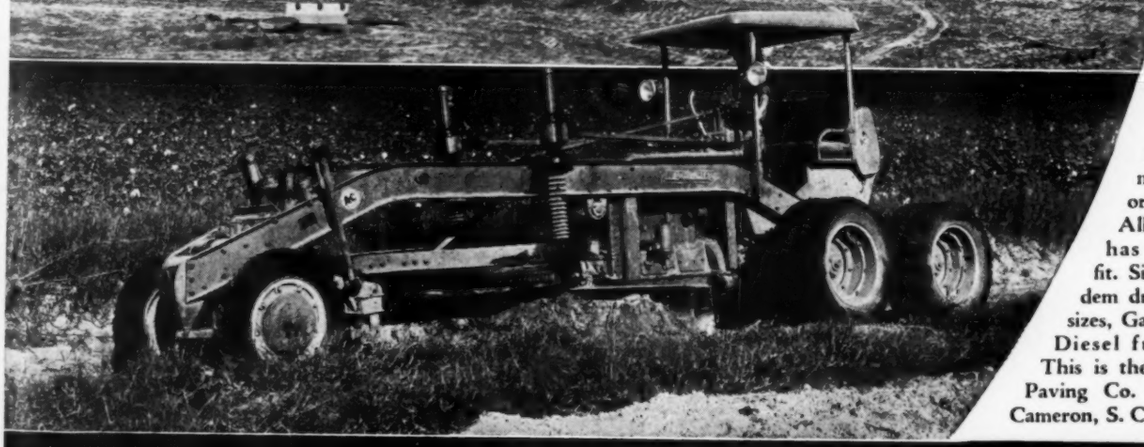
Operators call the "K" and "K-O" the sweetest pair of bulldozing tractors ever to level a grade. This "WK" is on the Connell & Laub job near Marquard Mills, O.

BLADE WORK

Topped by the big Power Controlled No. 14 Grader with the exclusive Leaning Frame feature, the A-C grader line is designed "to fit the job." This all A-C outfit — Model "L-O," No. 12 Grader and No. 54 Speed Patrol — are owned by Chaves County, N. M.

LONG HAULS

Where hauls are long, and high traveling speed important, the Speed Ace hauling unit is "the tool for the job." George W. Condon has 11 Speed Aces on this job at the Casper-Alcova Dam in Wyoming.

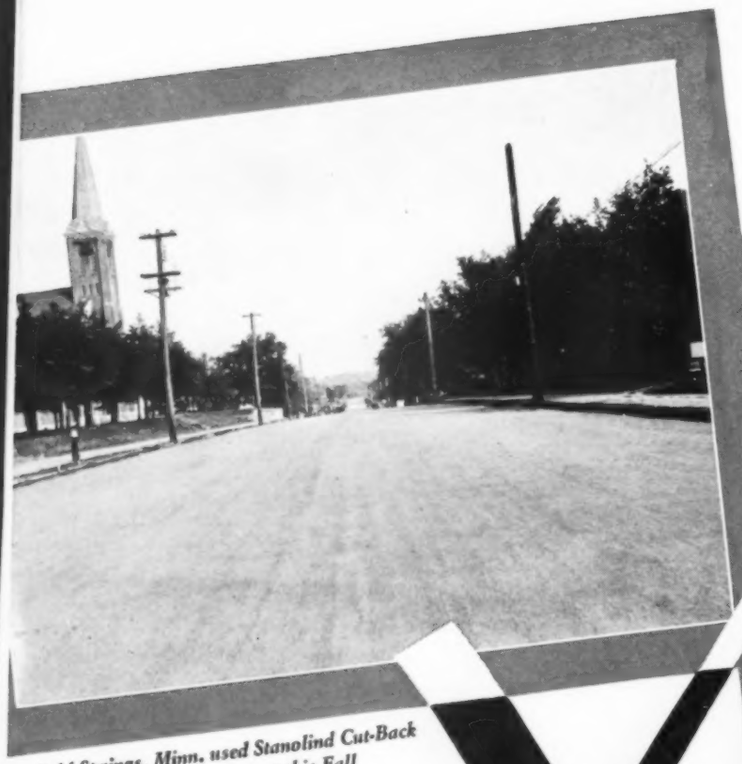


MAINTENANCE

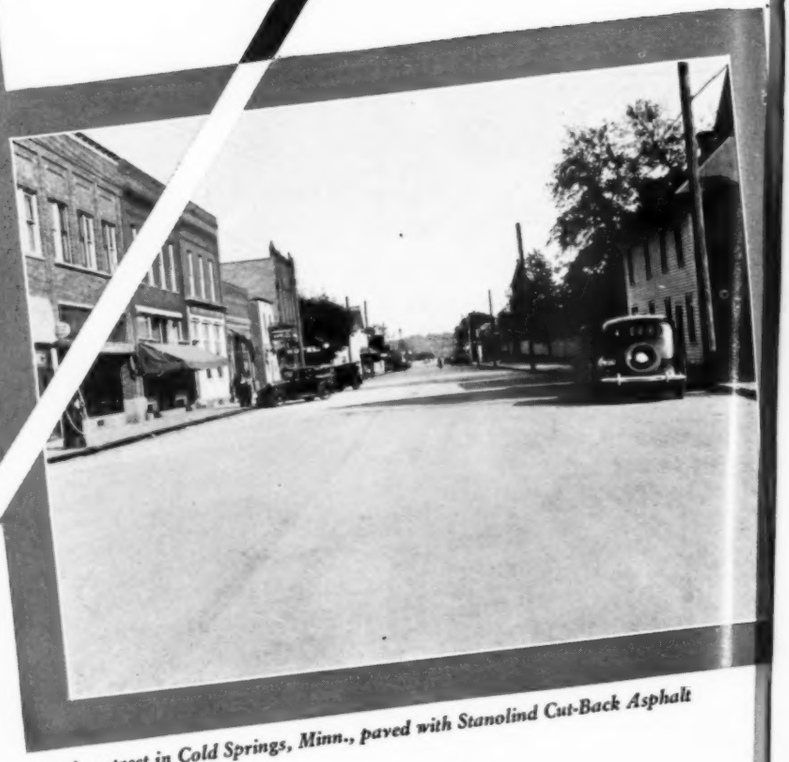
Whether the work is straight maintenance, oil mix, ditch work, or what not— Allis-Chalmers has a patrol to fit. Single or tandem drive. Two sizes, Gasoline or Diesel fuel oil. This is the Esty Paving Co. job, Cameron, S. C.

ALLIS-CHALMERS
TRACTOR DIVISION—MILWAUKEE, U. S. A.

Controlled Ignition **OIL TRACTORS**



Cold Springs, Minn. used Stanolind Cut-Back Asphalt on this street this Fall



Another street in Cold Springs, Minn., paved with Stanolind Cut-Back Asphalt

Check these Advantages of STANOLIND CUT-BACK ASPHALTS

AND SEE HOW THIS IDEAL PAVING MATERIAL FITS YOUR NEEDS!

- ✓ **Furnished in 5 grades to provide proper fluidity for different types of construction.**
- ✓ **Give a uniform, effective bond.**
- ✓ **Economical—low first cost, long life, and low maintenance costs.**
- ✓ **Simple in Application—Expensive equipment not needed.**
- ✓ **Provide non-skid, non-glaring surface, assuring the maximum in safety.**

Stanolind Cut-Back Asphalt has been used for the busiest streets in the world. It is the ideal paving material for every traffic requirement, providing *extra safety values* in a non-skid and non-glaring surface. More miles of road in the Middle West have been paved with Cut-Back in the last decade than with any other material. Take advantage of the experience of Standard representatives in selecting materials and methods. Their help is free—yours for the asking. Just phone your local Standard Oil (Indiana) office or write to

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PERFORMANCE *is* CONVINCING

OWNER	WORKING TIME COVERED	ESTIMATED INCREASED OUTPUT	ESTIMATED FUEL SAVINGS
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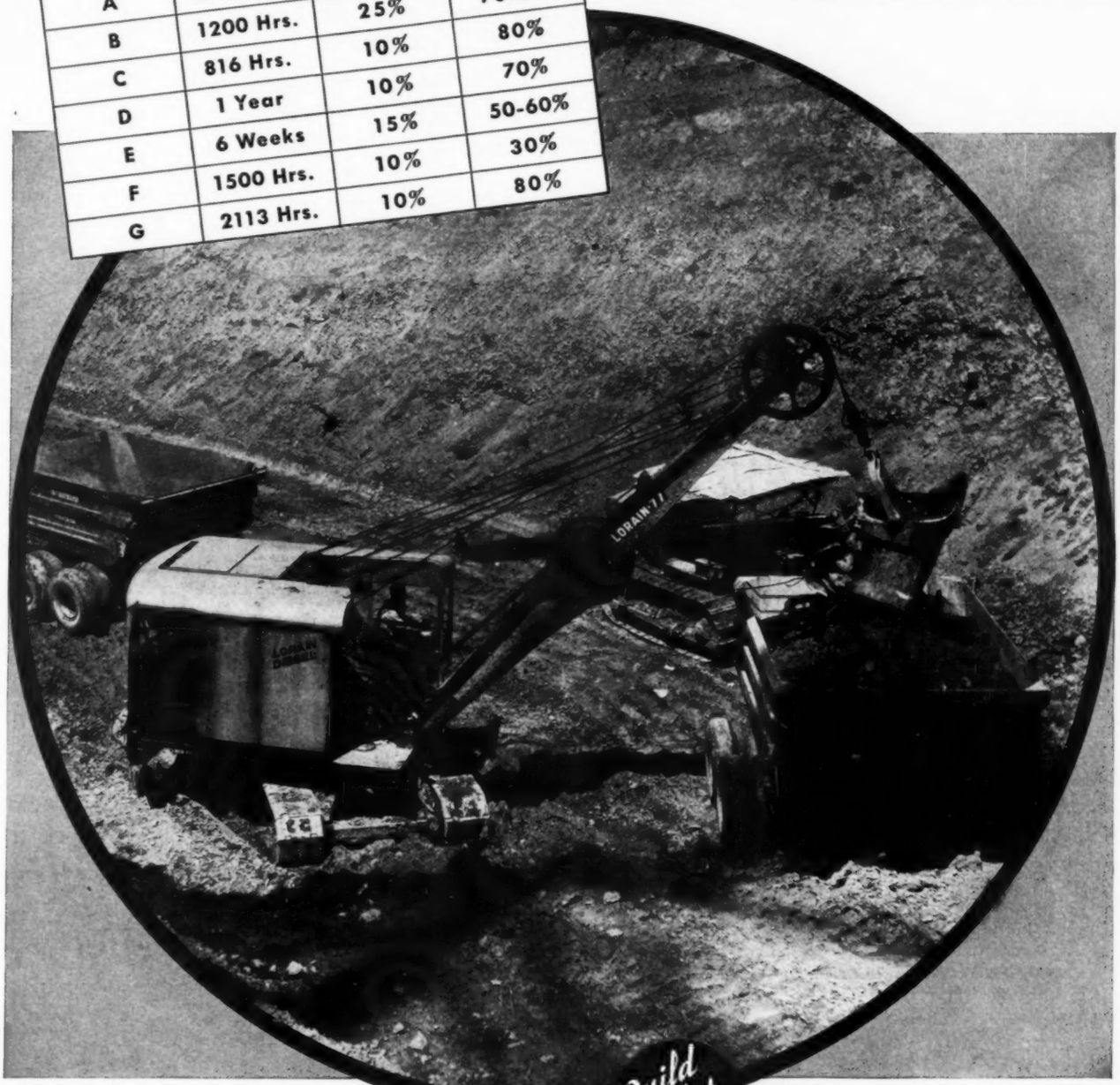
B	1200 Hrs.	25%	70-80%
C	816 Hrs.	10%	80%
D	1 Year	10%	70%
E	6 Weeks	15%	50-60%
F	1500 Hrs.	10%	30%
G	2113 Hrs.	10%	80%

FRED SLATE, Multnomah, Ore., is grading a 626,000 yd. job west of Portland, on which his 1½ yd. Diesel Lorain 77 is reported to be moving material at a fuel cost of 2/10c per yd.... Similar reports, as given in the table, prove more than ever, that Lorains, combining efficient Center Drive design with modern Diesel power, will move more material, faster and at lower costs.



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LORAINS • 2 to 3/8 yd.

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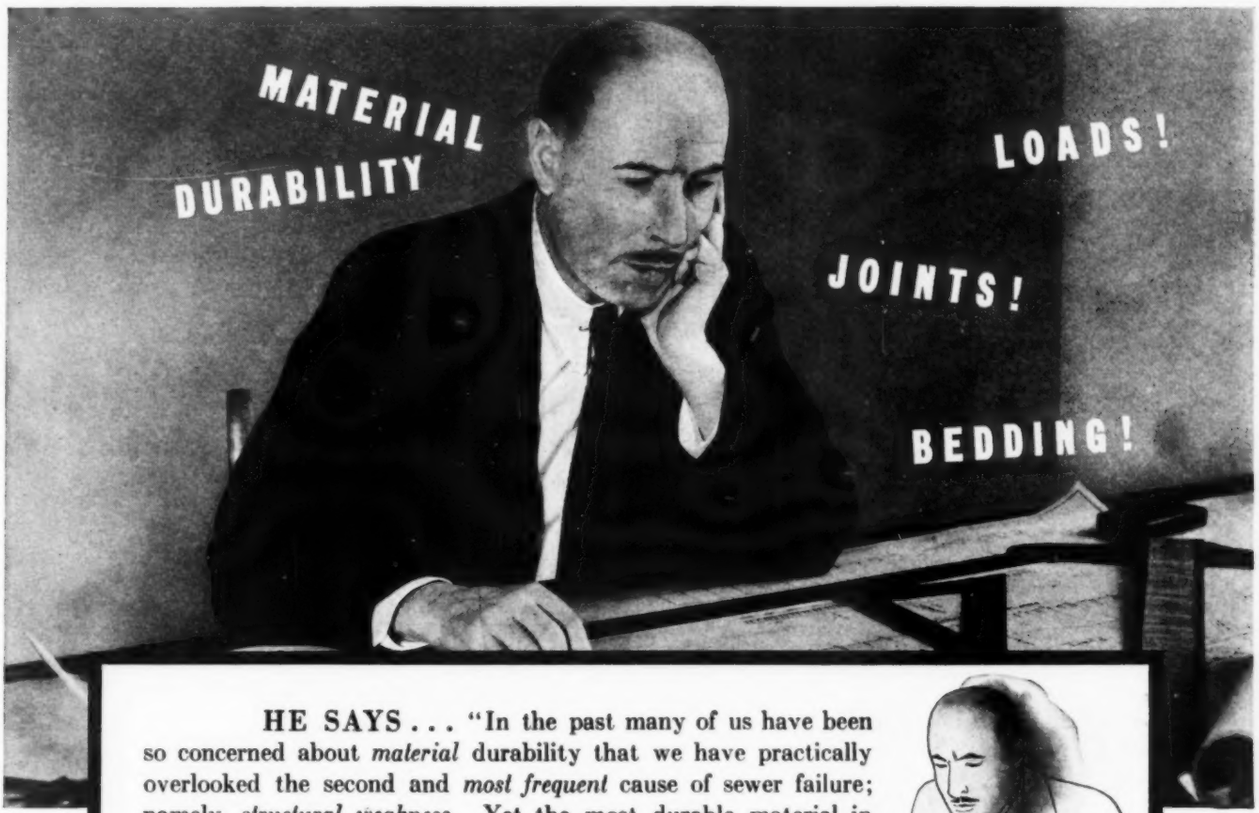
THEW CENTER DRIVE

The THEW SHOVEL Co.

LORAIN • • OHIO

THIS ENGINEER HAS DISCOVERED

AN IMPORTANT FACT ABOUT SEWERS



HE SAYS . . . "In the past many of us have been so concerned about *material* durability that we have practically overlooked the second and *most frequent* cause of sewer failure; namely, *structural weakness.* Yet the most durable material in the world is absolutely worthless for sewers, unless it can be made to function efficiently as a structure. Past experience proves that."

● Guided by this same logic, many cities are specifying corrugated metal pipe for sewers — especially in the larger diameters. Besides saving time and money in installation, this strong, flexible pipe definitely eliminates the worry of structural failure. This fact is proved by 40 years of experience.

What About Material Durability?

Here's where *Asbestos Bonded* Armco pipe solves your problem. This improved corrugated pipe is made of the same highly refined iron which is showing such remarkable durability in sewers laid nearly 30 years ago. In addition, it is paved and fully coated with a special bituminous material, permanently "*bonded*" to the pipe by a special Armco process. Mail the coupon for complete information. Armco Culvert Manufacturers Association, 703 Curtis St., Middletown, Ohio.

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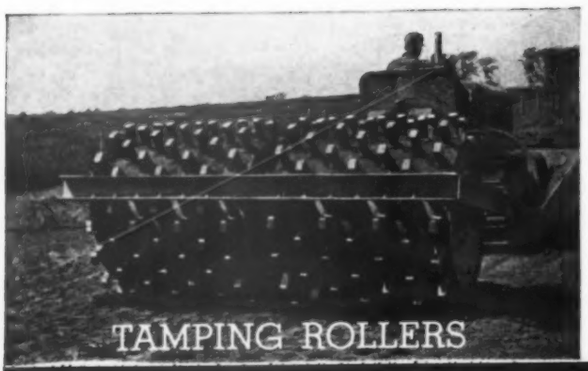

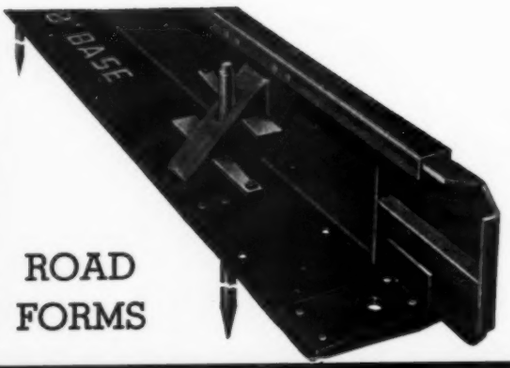

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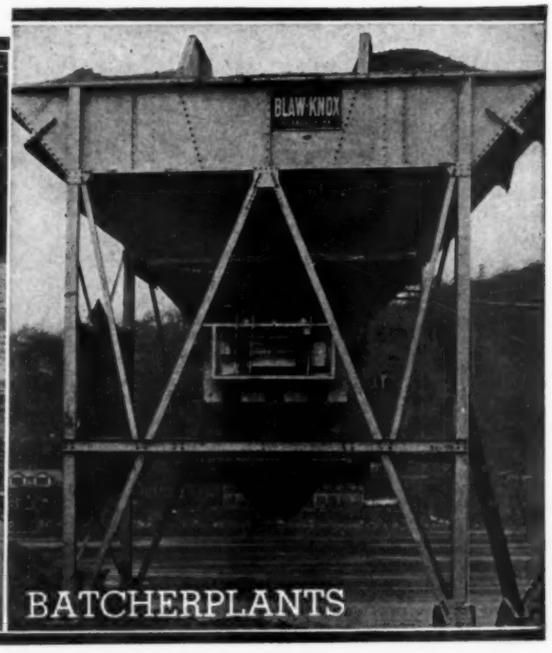

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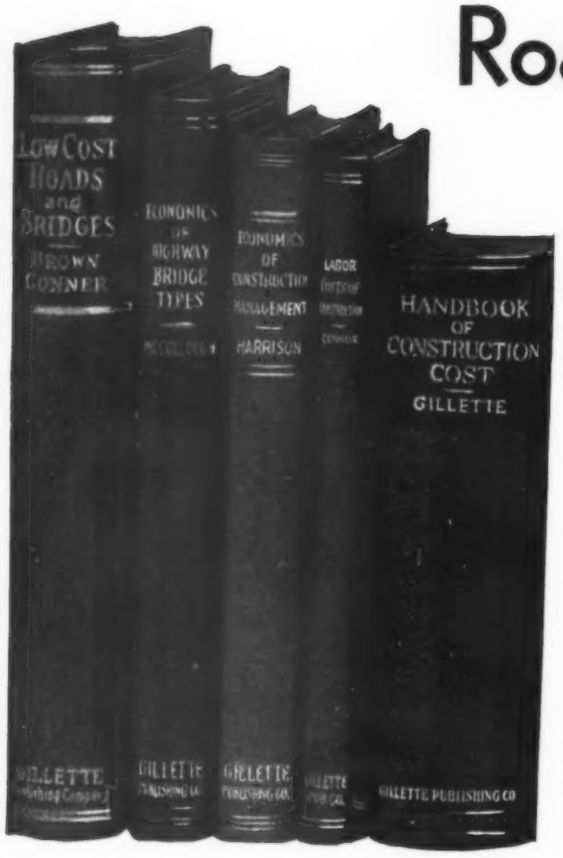

The Road Builders' Library has been planned to give in a clear, concise form, the most up-to-date data available. In its six volumes you will find summarized the experience and practical knowledge of some of the most successful highway engineers. It is invaluable as a reference source for your NEW jobs. It tells how similar work was effectively and profitably handled elsewhere—pointing out what the limitations are and how results may best be obtained. It gives you useful calculations already worked out, tables, charts, and other useful data that provides a short-cut to *Profit-Making*.

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The *rate* at which a well-traveled highway pays for itself increases as upkeep is lessened. The total profit of the highway is increased by giving it longer life.

A brick pavement is generally conceded to have the longest life and the lowest upkeep. Common observation: many a veteran brick street rides as well and looks better than other types from 20 to 30 years younger. The reason is because weather cannot start damage which traffic hammers into final destruction.

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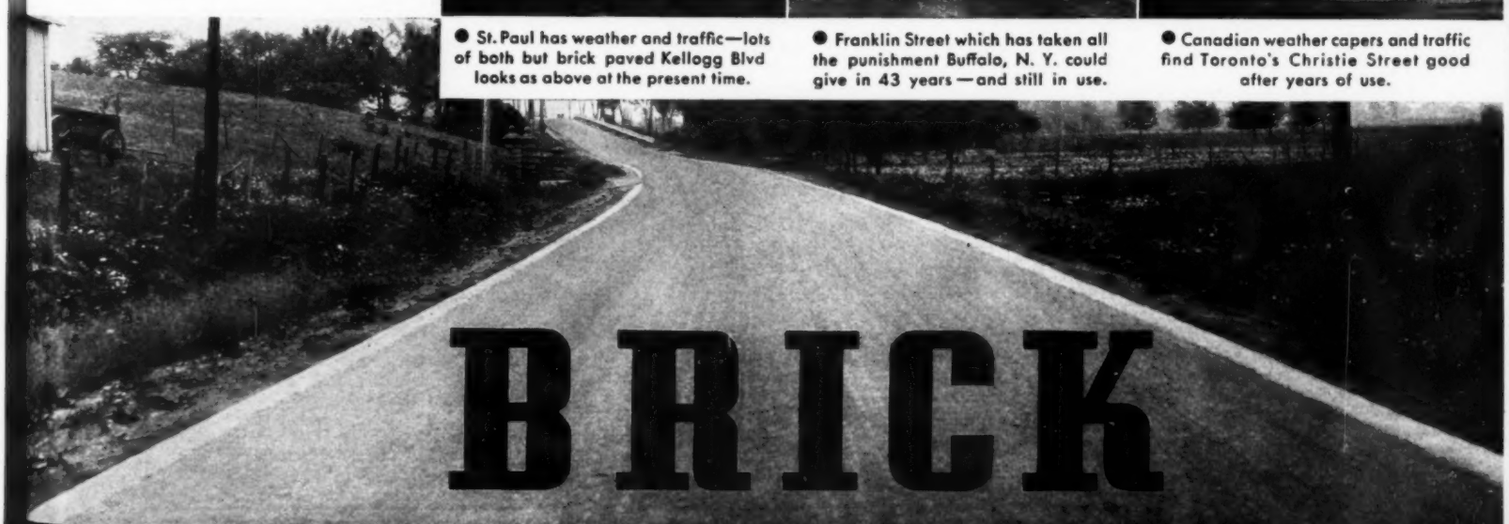
● St. Paul has weather and traffic—lots of both but brick paved Kellogg Blvd looks as above at the present time.

● Franklin Street which has taken all the punishment Buffalo, N. Y. could give in 43 years—and still in use.

● Canadian weather capers and traffic find Toronto's Christie Street good after years of use.



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